

A reproduction of Leonardo da Vinci's Mona Lisa painting, showing a woman with a subtle smile, wearing a red garment and a necklace, against a dark background.

Leonardo

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Leonardo da Vinci

(1452-1519)



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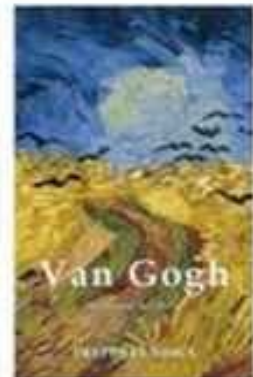
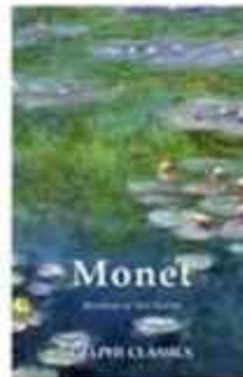
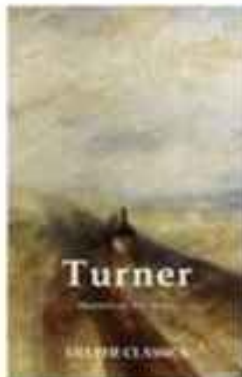
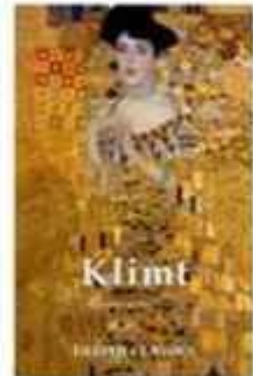
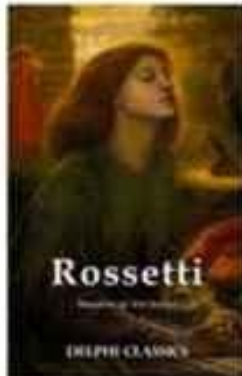
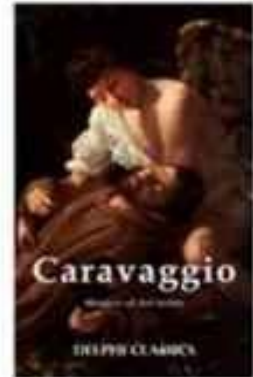
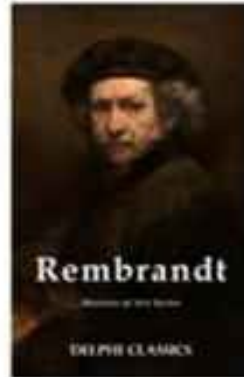
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A stylized, handwritten signature of Leonardo da Vinci in black ink, featuring a large, flowing 'L' and 'D'.

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The Paintings



Vinci, a town in Tuscany — the birthplace of the world's most famous painter



Leonardo's childhood home in Anchiano, close to his birthplace town of Vinci

TOBIAS AND THE ANGEL



Completed by 1480, this altar painting is attributed to the workshop of Andrea del Verrocchio and is now housed in the London National Gallery. Some art historians believe that Leonardo, who was a member of Verrocchio's studio at the time, had painted some of the work, most likely the fish. David Alan Brown, of the National Gallery in Washington, attributes the painting of the little dog to Leonardo as well. If these scholars are correct, then this would be the first extant painting of the renowned artist.

The image depicts a scene from the Book of Tobit, in which Tobias, son of Tobit, meets the angel Raphael, without realising his true identity. Tobias had been sent by his father to collect a sum of money that the latter had deposited some time previously in the distant land of Media. According to the story, Raphael represented himself as Tobit's kinsman Azariah, and offered to aid and protect Tobias on his journey. Under the guidance of Raphael, Tobias made the journey to Media, accompanied by his faithful dog. Along the way, when washing his feet in the river Tigris, Tobias was attacked by a fish that tried to swallow his foot. Under the instructions of the angel he seized it and removed the heart, liver and gall bladder to make a special medicine. Raphael then told the young man how the fish could be used to cure Tobias' cousin, a young woman named Sarah, who was plagued by the demon of lust. Asmodeus, 'the worst of demons' had previously abducted and killed every man she married. Through the angel's aid, Tobias was successful in driving the demon away from his cousin and the two were speedily married.





Detail



Detail



Detail of Archangel Raphael — some scholars claim Leonardo was a model for this subject

MADONNA OF THE POMEGRANATE



Also known as *The Dreyfus Madonna*, this oil painting has been attributed to Verrocchio and Lorenzo di Credi, as well as Leonardo. The anatomy of the Christ Child is so poor as to discourage firm attribution by most critics, while some believe that it is a work of Leonardo's youth. This attribution was made by Suida in 1929. Other art historians, such as Shearman and Morelli, attribute the work to Verrocchio.





Detail

THE MADONNA OF THE CARNATION



This oil painting was completed by 1480 and is permanently displayed at the Alte Pinakothek gallery in Munich. The central subject is the young Virgin Mary with Baby Jesus on her lap. Mary is seated and wears precious clothes and jewellery. With her left hand, she is holding a carnation, which has been interpreted as a healing symbol. Originally this painting was thought to have been created by Andrea del Verrocchio, but art historians now tend to agree it is Leonardo's work. The canvas is the only work by Leonardo that is permanently on display in Germany.





Detail

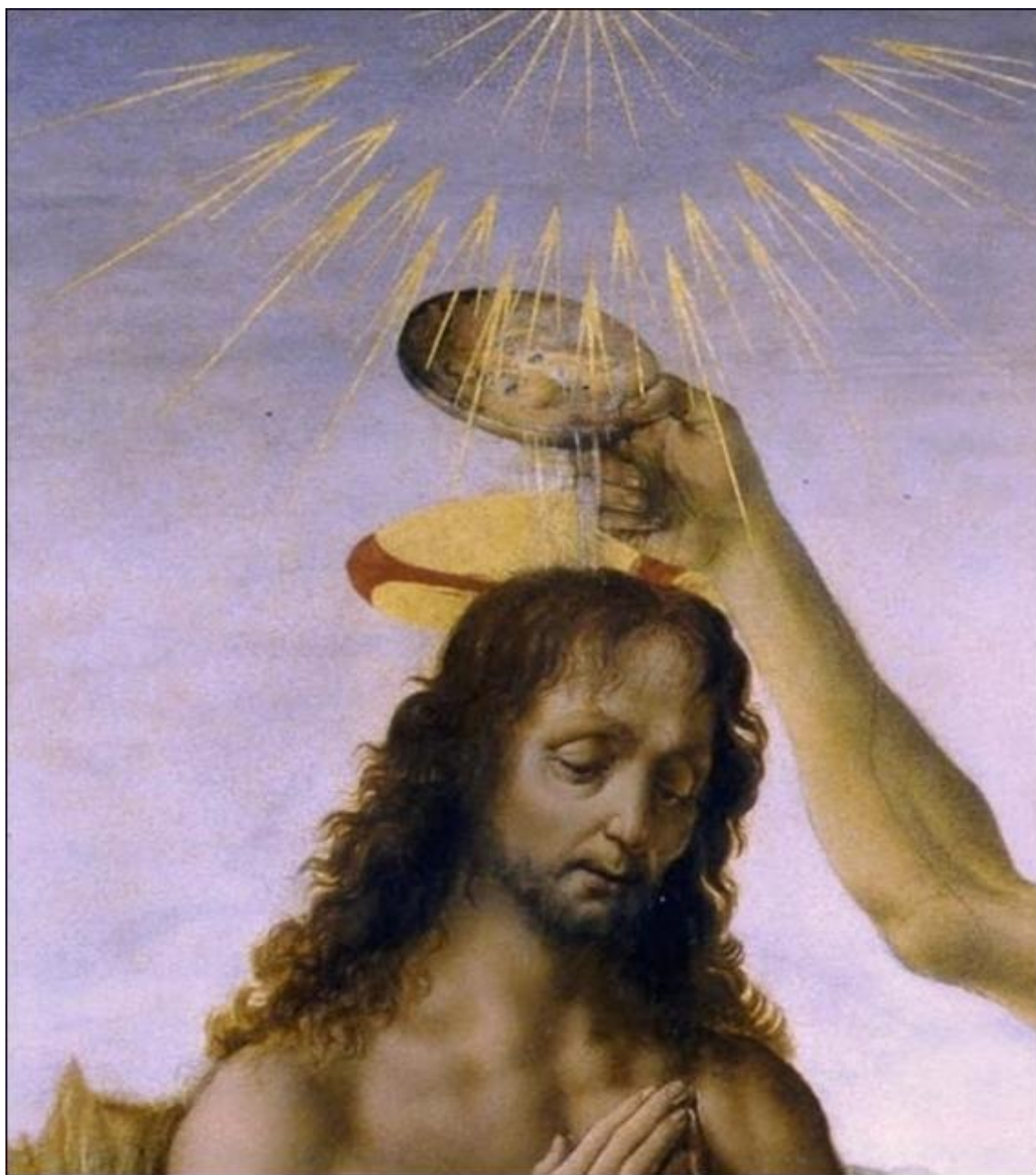
THE BAPTISM OF CHRIST



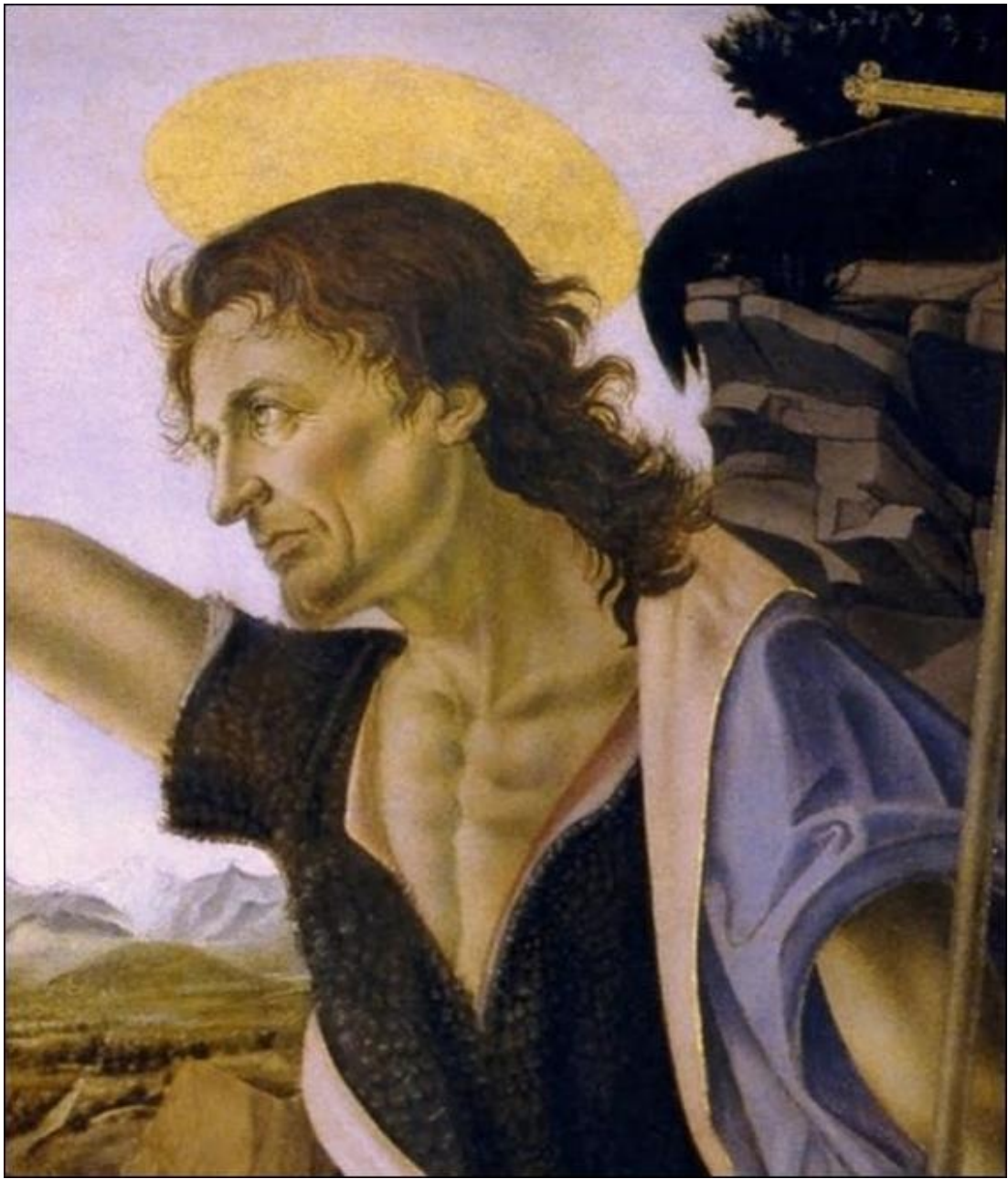
This painting was finished circa 1475 in the studio of the painter Andrea del Verrocchio and the work is now generally ascribed to him and his young pupil Leonardo. Some art historians believe that other members of Verrocchio's workshop had a hand in the painting as well. The picture depicts the Baptism of Jesus by John the Baptist as recorded in the Biblical Gospels of Matthew, Mark and Luke. The angel to the left is recorded as having been painted by Leonardo. The work is now permanently housed in the Uffizi Gallery in Florence.

Commissioned by the Church of S. Salvi, the painting was later transferred to the Vallumbrosan Sisterhood in Santa Verdiana. In 1810 the work entered the collection of the Accademia and passed to the Uffizi in 1959. In the 16th century the work was discussed in Giorgio Vasari's *Lives of the Painters* in the biographies of both Verrocchio and Leonardo da Vinci.





Detail



Detail



Detail

THE ANNUNCIATION



Painted by Leonardo and Andrea del Verrocchio, this work dates from circa 1472–1475 and is now housed in the Uffizi Gallery, Florence. The painting portrays an angel holding a Madonna lily, a symbol of Mary's virginity and of the city of Florence. It is supposed that Leonardo originally copied the wings from those of a bird in flight, but they have since been altered and lengthened by a later artist

When *The Annunciation* came to the Uffizi in 1867 from the Olivetan monastery of San Bartolomeo, it was ascribed to Domenico Ghirlandaio, who was also an apprentice to Andrea del Verrocchio. In 1869, Karl Eduard von Liphart, the central figure of the German expatriate art colony in Florence, recognised it as an early work by Leonardo, one of the first attributions of a surviving work to the artist. When the *Annunciation* was x-rayed, Verrocchio's work was clearly evident, while Leonardo's angel was invisible.





Detail



The angel's wings were inspired by real life birds' feathers, a technique unprecedented in Western art



Detail

THE BENOIS MADONNA



It is believed that this is the first independent work painted by Leonardo, when no longer under the direct tutelage of his master Verrocchio. There are two of Leonardo's preliminary sketches for this piece in the British Museum, as the composition of a Madonna and Child proved to be one of Leonardo's most popular subjects. This work was extensively copied by young painters, including Raphael, whose own version *The Madonna of the Pinks* reveals Leonardo's influence on the younger artist.

For centuries, *The Benois Madonna* was considered lost. In 1909, the architect Leon Benois sensationally exhibited it in St Petersburg as part of his father-in-law's collection. The painting had been apparently brought from Italy to Russia by the notable connoisseur Alexander Korsakov in the 1790s. Upon Korsakov's death, it was sold by his son to the Astrakhan merchant Sapozhnikov for 1400 roubles and so passed by inheritance to the Benois family in 1880. After many disagreements regarding attribution, Leon Benois sold the painting to the Imperial Hermitage Museum in 1914. Since then, it has been housed in St. Petersburg.





Detail

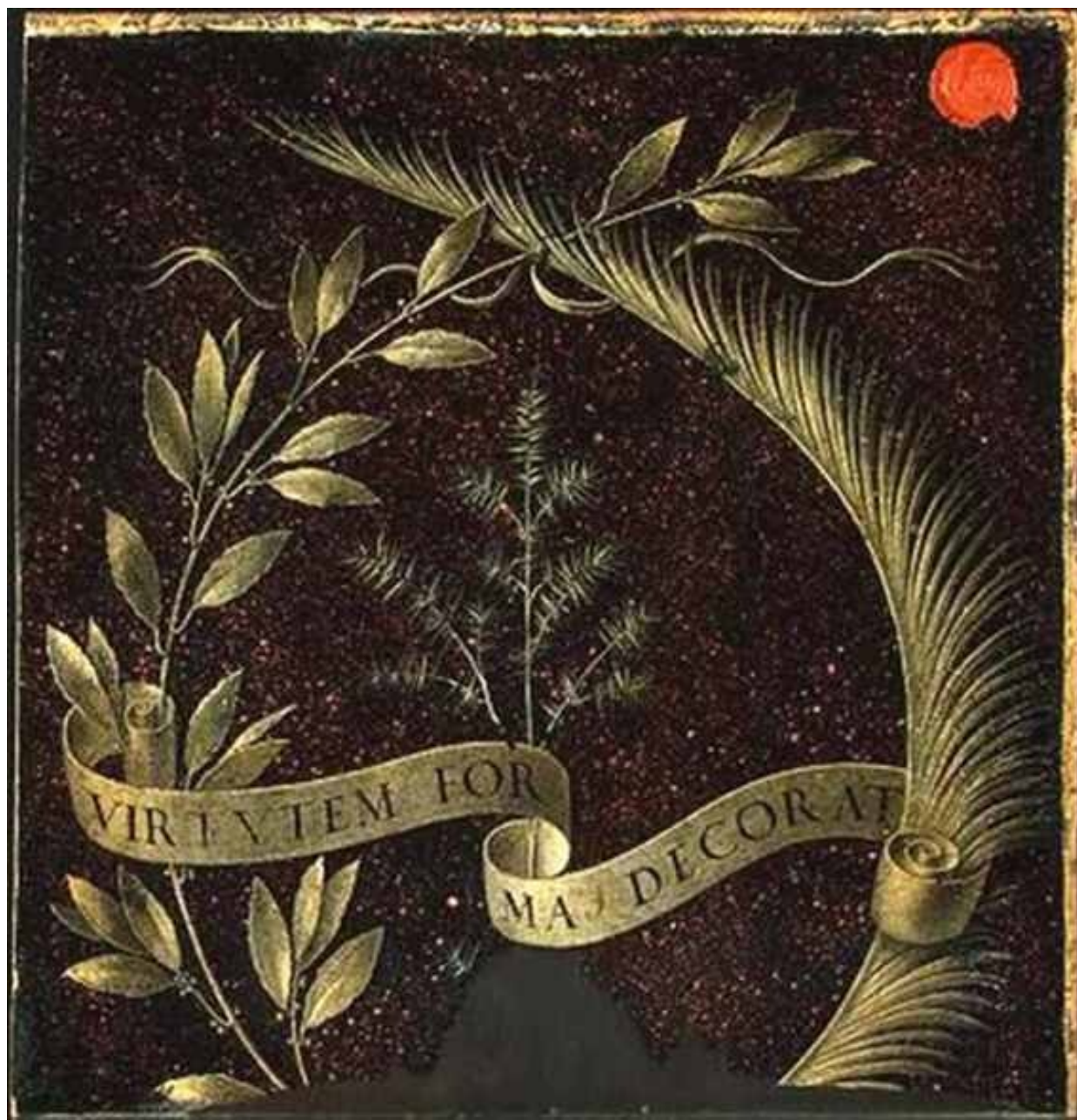
PORTRAIT OF GINEVRA DE' BENCI



Ginevra De' Benci was a Florentine aristocrat, admired for her intelligence by her contemporaries and immortalised in this famous portrait. The oil-on-wood painting was acquired by the National Gallery of Art in Washington, D.C., in 1967, for \$5 million, paid to the Princely House of Liechtenstein, a record price at the time. Currently, it is the only painting by Leonardo in the Americas.

It is known that Leonardo painted a portrait of Ginevra de' Benci in 1474, possibly to commemorate her marriage that year to Luigi di Bernardo Niccolini at the age of 16. However, according to Giorgio Vasari, Ginevra was not the daughter of Amerigo de' Benci but his wife. The painting's imagery and the text on the reverse of the panel support the identification of this picture. Directly behind the young lady in the portrait is a juniper tree, serving as an amusing play upon her name. The reverse of the portrait is decorated with a juniper sprig encircled by a wreath of laurel and palm and is inscribed with the phrase VIRTUTEM FORMA DECORAT ('beauty adorns virtue').

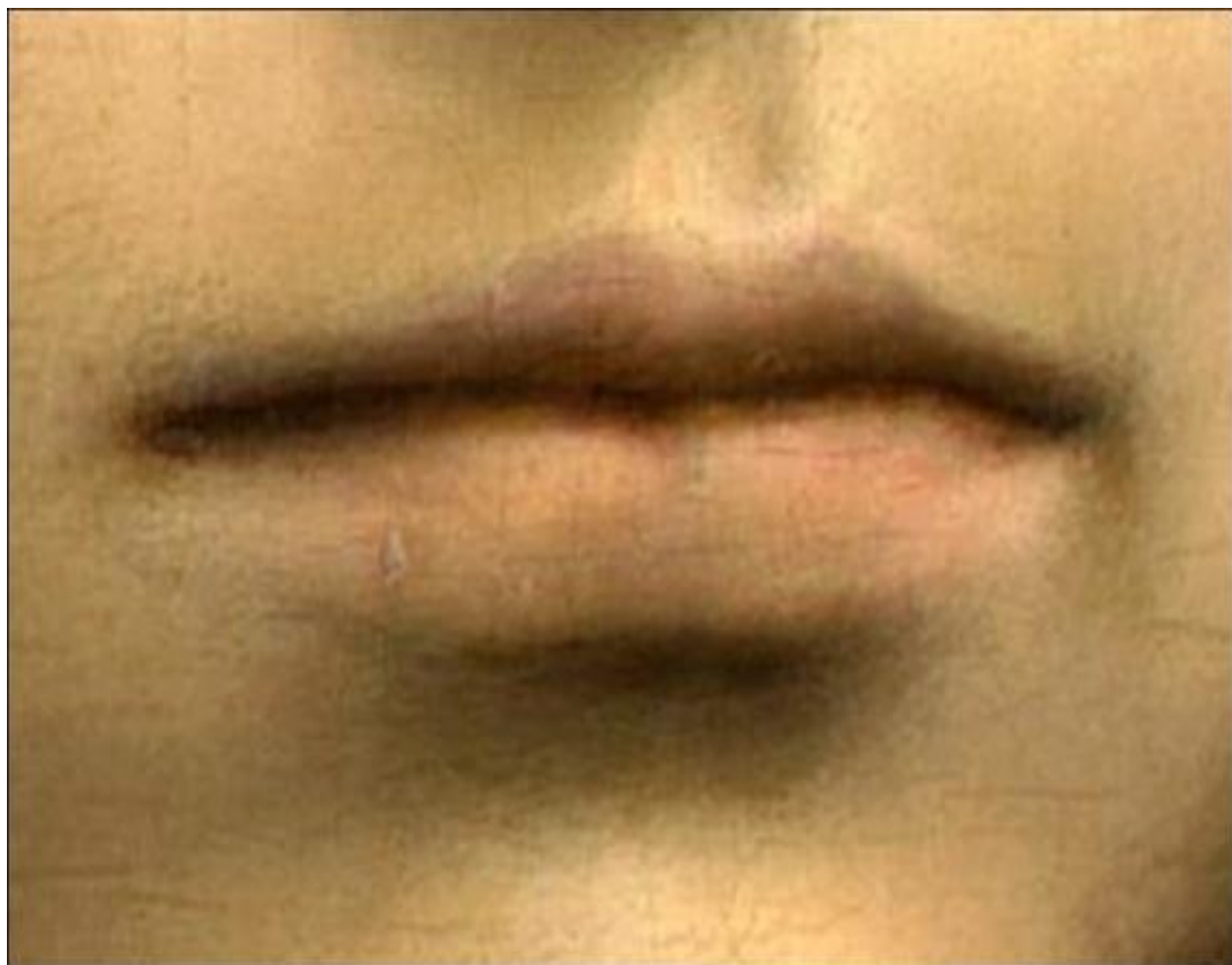




The reverse of the portrait



Detail



Detail

ST. JEROME IN THE WILDERNESS

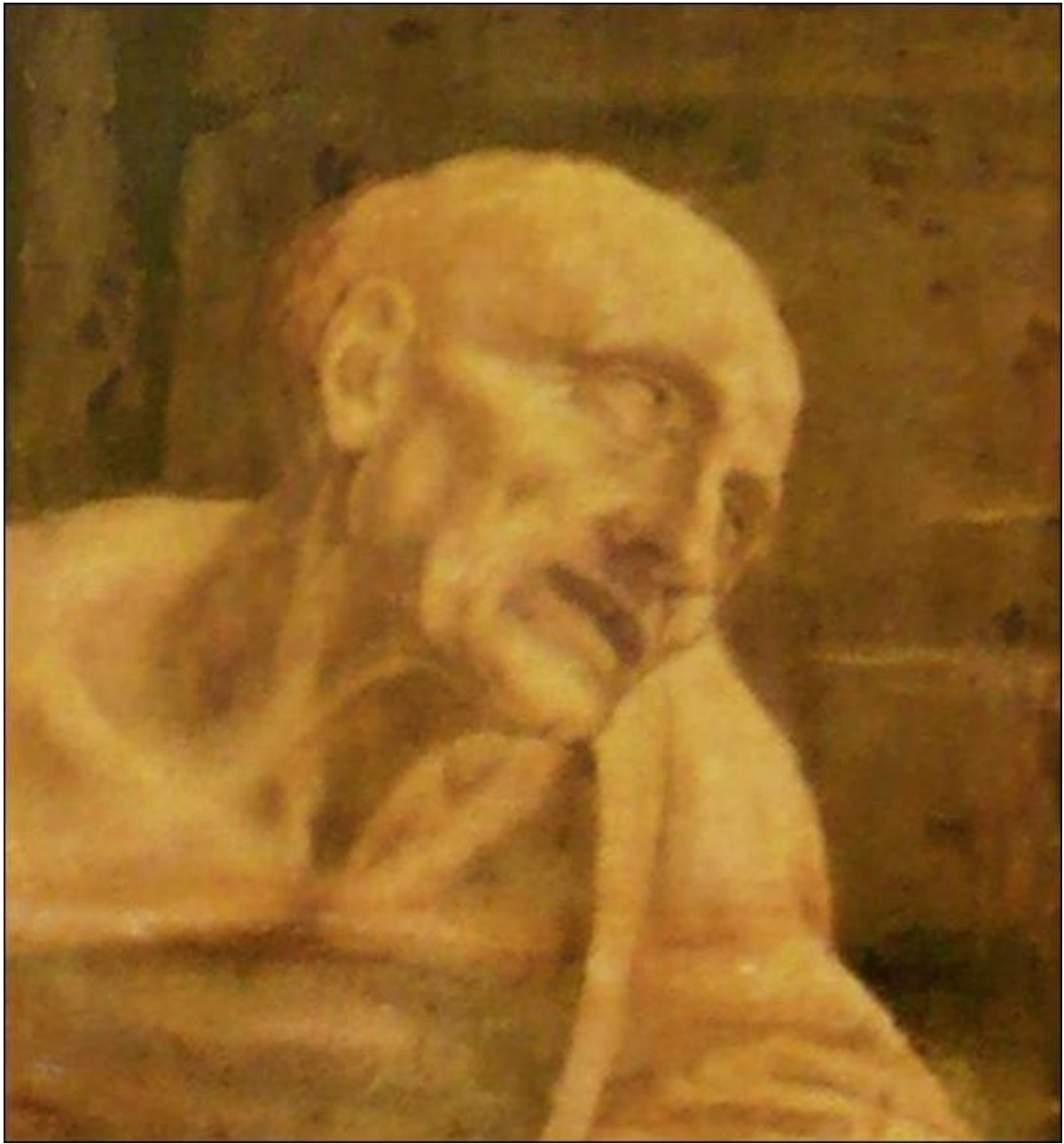


Begun in 1480, this is an unfinished work, now housed in the Vatican Museums, Rome. The canvas depicts St. Jerome during his retreat to the Syrian desert, where he lived the life of a hermit. The saint kneels in a rocky landscape, gazing toward a crucifix, which can be discerned faintly sketched in at the extreme right of the painting. In Jerome's right hand he holds a rock with which he is traditionally shown beating his chest in penance. At his feet is the lion that became his loyal companion after he extracted a thorn from its paw. The lion, the stone and a cardinal's hat are the traditional attributes of the saint. To the right-hand side, the only discernible feature is a faintly-sketched church, seen through the opening in the rocks. The church's presence may allude to Jerome's position in Western Christianity as one of the Doctors of the Church.

The composition of the painting is innovative due to the trapezoid form of the saint's figure. The angular forms contrast with the sinuous outline of the lion, which transcribes an "S" across the bottom of the painting. Interestingly, the form of St. Jerome prefigures that of the Virgin Mary in the famous *Madonna of the Rocks*.

The panel has been reduced in size and the remaining part was cut in two at some point in its history and reassembled by the early 19th-century collector, Cardinal Fesch, the uncle of Napoleon Bonaparte. Popular legend claims that the Cardinal discovered the part of the panel with the saint's torso being offered as a table-top in a shop in Rome. Many years later, he found another piece being used as a wedge for a shoemaker's bench.





Detail

THE ADORATION OF THE MAGI



Leonardo was given this commission by the Augustinian monks of San Donato a Scopeto in Florence, but he departed for Milan the following year, leaving the painting unfinished. It has been housed in the Uffizi Gallery in Florence since 1670.

In the canvas, the Virgin Mary and Child are depicted in the foreground and form a triangular shape with the Magi kneeling in adoration. Behind them is a semicircle of accompanying figures, including what may be a self-portrait of the young Leonardo (on the far right). In the background on the left is the ruin of a pagan building, on which several workmen can be seen, apparently repairing the structure. On the right are men on horseback fighting and a sketch of a rocky landscape.

The ruins are a possible reference to the Basilica of Maxentius, which, according to Medieval legend, the Romans claimed would stand until a virgin gave birth. It is supposed to have collapsed on the night of Christ's birth, though in fact it was not built until a later date. The ruins dominate a preparatory perspective drawing by Leonardo, which also includes the fighting horsemen. The palm tree in the centre has associations with the Virgin Mary, partly due to the phrase: 'You are stately as a palm tree' from the Song of Solomon.





Detail: possible self-portrait



Detail

THE VIRGIN OF THE ROCKS (LOUVRE)



This is one of two paintings by Leonardo of the same subject, which are identical except for two significant details. The current painting is usually housed in the Louvre and the other is on display in the National Gallery, London. Both paintings depict the Madonna and Christ Child with the infant John the Baptist and an angel, in a rocky setting that gives the paintings their usual name. The significant compositional differences are in the gaze and right hand of the angel. There are many minor ways in which the works differ, including the colours, lighting, flora and the use of *sfumato* (the technique of softening lines).

The Louvre version is considered by most art historians to be the earlier of the two, dating from around 1483-1486. Most authorities agree that the work is entirely by Leonardo and it is 8cm taller than the London version. The first certain record of the painting was in 1625, when it was part of the French royal collection. It is generally accepted that this work was produced for a commission of 1483 in Milan. It is believed it was privately sold by Leonardo and the London version painted at a later date to fulfil the commission.





Detail



Detail

THE VIRGIN OF THE ROCKS (NATIONAL GALLERY)



Originally thought to have been partially painted by Leonardo's assistants, recent studies by the National Gallery have revealed that this work may have been painted entirely by Leonardo. It was commissioned for the chapel of the Confraternity of the Immaculate Conception, in the church of San Francesco Maggiore in Milan. It was sold by the church, very likely in 1781, and certainly by 1785, when it was bought by Gavin Hamilton, an English painter and dealer, who took it to England. After passing through various collections, it was bought by the National Gallery in 1880.

In June 2005, the painting was examined by infra-red reflectogram. This imaging revealed a draft of a different painting beneath the visible one. The draft portrays a woman, probably kneeling, with her right hand outstretched and her left on her heart. Some researchers believe that the artist's original intention was to paint an adoration of the infant Jesus. Many other pentimenti are also visible under x-ray or infra-red examination.





Detail



Detail



Detail



Left-hand wing of the altar piece, probably by Ambrogio de Predis

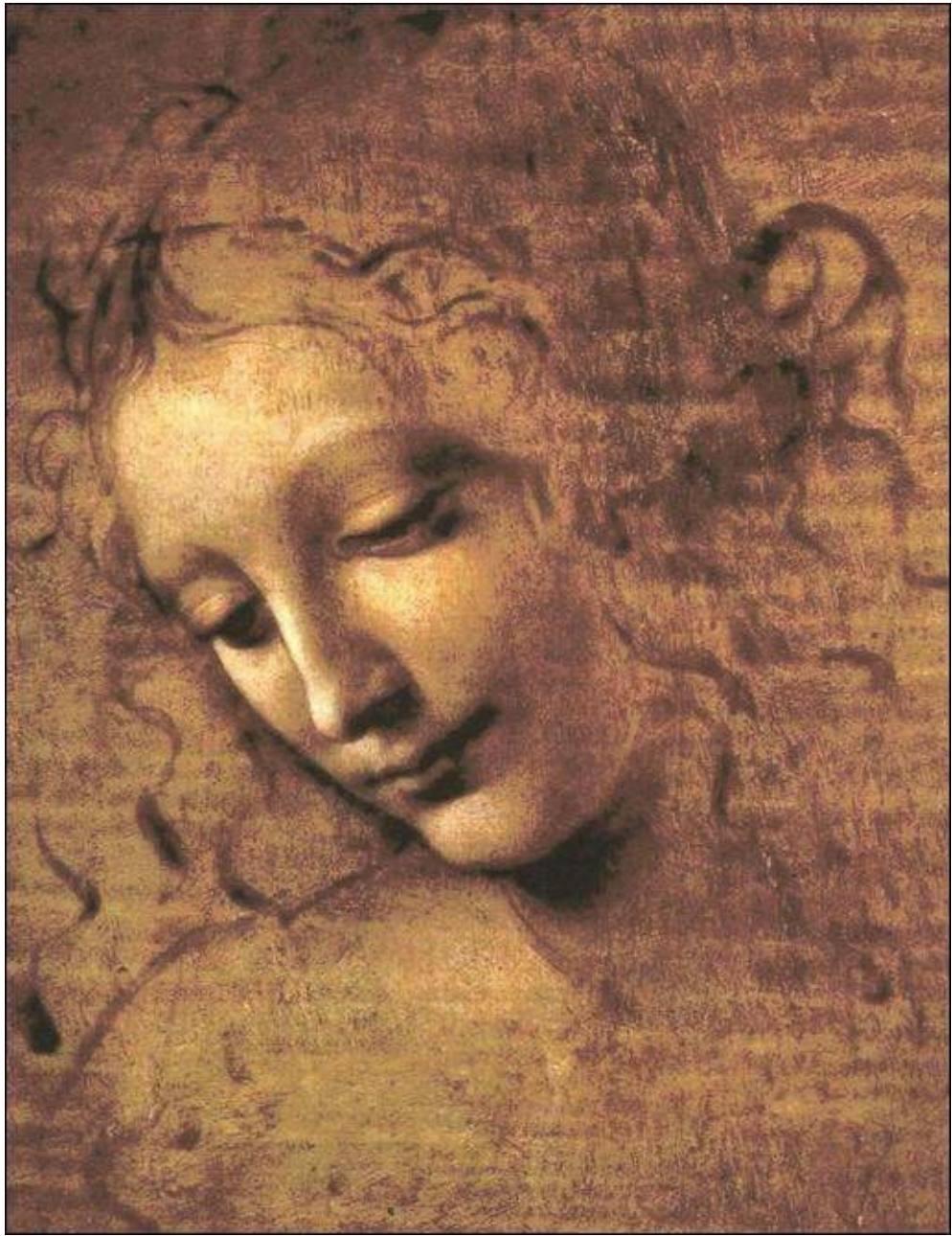


Right-hand wing of the altar piece, probably by Luini

THE HEAD OF A WOMAN



Also known as *La Scapigliata*, this painting dates from approximately 1500 and is housed in the Galleria Nazionale of Parma. The work was left unfinished and was mentioned for the first time in the House of Gonzaga collection in 1627. It is perhaps the same work that Ippolito Calandra, in 1531, had suggested to hang in the bedroom of Margaret Paleologa, wife of Federico II Gonzaga. In 1501, the marquesses wrote to Pietro Novellara asking if Leonardo could paint a Madonna for her privately.



LITTA MADONNA



Housed in the Hermitage Museum in Saint Petersburg, this canvas is generally attributed to Leonardo, though some cite Giovanni Antonio Boltraffio as the artist. There are numerous replicas of the *Litta Madonna* by other Renaissance painters and there is a preliminary sketch by Leonardo of the Madonna's head in the Louvre.

The image depicts the Madonna nursing the infant Jesus, whose awkward posture has led some scholars to attribute parts of the painting to Leonardo's pupil Boltraffio. Other clues that suggest Leonardo was not the only artist to have a hand in the painting are the harsh outlines of the Madonna and Child and the simplistic landscape.

This work was painted sometime in the 1480s for the Visconti rulers of Milan and soon passed to the Litta family, in whose possession it would remain for centuries. In 1865, Alexander II of Russia acquired the painting from Count Litta, the former minister to St. Petersburg and deposited the painting in the Hermitage Museum. The museum had the painting transferred from wood to canvas.





Detail



Detail



The preliminary sketch, housed in the Louvre

LADY WITH AN ERMINE



This painting was completed by 1490 and the subject of the portrait has been identified as Cecilia Gallerani, who was the mistress of Lodovico Sforza, Duke of Milan, to whom Leonardo was in service. The piece is housed in the Czartoryski Museum, Kraków, Poland and is cited in the museum's guide as the first truly modern portrait. The portrait was painted in oils on a wooden panel, at a time when the medium of oil paint was relatively new to Italy. Leonardo was one of the first artists to adopt the new medium, skilfully exploiting its qualities to great effect. This work particularly demonstrates Leonardo's expertise in depicting the human form. The outstretched hand of Cecilia was painted with great detail. Leonardo delineates every contour of each fingernail, each wrinkle around her knuckles and even the flexing of the tendon in her bent finger.

At the time of her portrait, Cecilia was about sixteen. She was one of a large family, neither rich nor noble. Her father served for a time at the Duke's court. Cecilia was renowned for her beauty, her scholarship and her poetry. She was betrothed at the age of about ten years to a young nobleman of the house of Visconti, but the marriage was called off. Cecilia became the mistress of the Duke and bore him a son, though he chose to marry a girl from a nobler family, Beatrice d'Este.

The painting portrays a half-length figure, the body of the young woman turned at a three-quarter angle towards her right, with her face turned towards her left. Her gaze is directed neither straight ahead, nor towards the viewer, but points indirectly beyond the picture's frame. In her arms Cecilia holds a small white-coated stoat, known as an ermine. Cecilia's dress is comparatively simple, revealing that she is not a noblewoman. Her coiffure, known as a "coazone", confines her hair smoothly to her head with two circlets of hair bound on either side of her face and a long plait at the back. Her hair is held in place by a fine gauze veil with a woven border of gold-wound threads, a black band and a sheath over the plait. There are several interpretations of the significance of the ermine in her portrait. The ermine, a stoat in its winter coat, was a traditional symbol of purity, as it was believed that an ermine would face death rather than soil its white coat.

Lady with an Ermine was acquired in Italy by Prince Adam Jerzy Czartoryski, the son of Princess Izabela Czartoryska and Prince Adam Kazimierz Czartoryski in 1798 and incorporated into the Czartoryskis' family collections at PuBawy in

1800. The inscription on the top-left hand corner of the painting, LA BELE FERIONIERE. LEONARD D'AWINCI., was probably added by a restorer shortly after its arrival in Poland and before the background was overpainted. The painting travelled extensively in the nineteenth century. For example, Princess Czartoryski rescued it in advance of the invading Russian army in 1830, then concealed the painting, sending it to Dresden and on to the Czartoryski place of exile in Paris, the Hôtel Lambert, finally returning it to Kraków in 1882. In 1939, almost immediately after the German occupation of Poland, it was seized by the Nazis and sent to the Kaiser Friedrich Museum in Berlin. In 1940 Hans Frank, the Governor General of Poland, requested that it be returned to Kraków, where it previously hung in his suite of offices. At the end of the Second World War, *Lady with an Ermine* was discovered by Allied troops in Frank's country home in Bavaria. It has since returned to Poland and is once more on display at the Czartoryski Museum in Kraków.





Detail



Detail

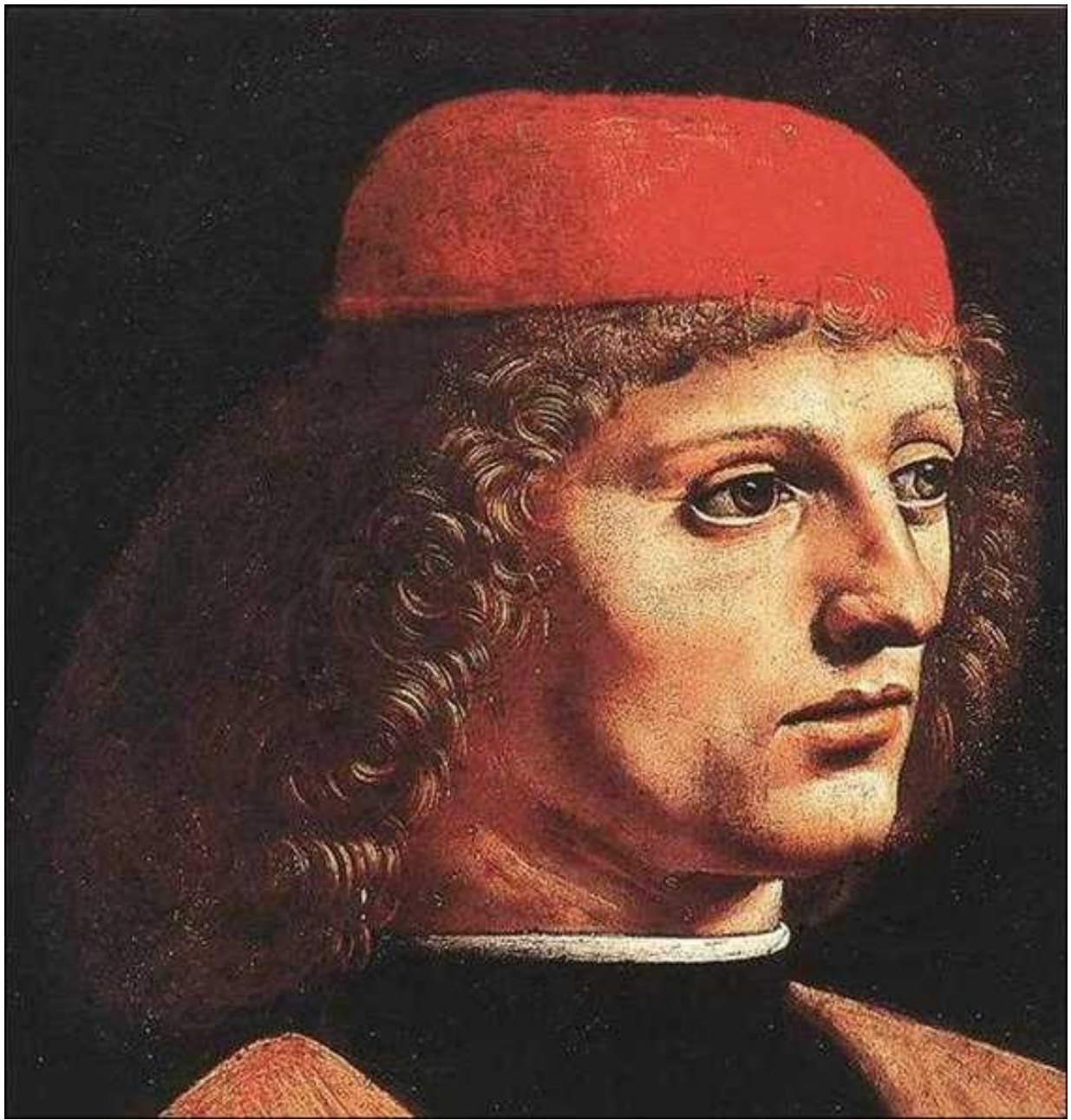
PORTRAIT OF A MUSICIAN



This oil on wood painting has been attributed to Leonardo by some scholars and was probably painted in 1490. The subject of the painting was at one time thought to be Franchino Gaffurio, who was the maestro di cappella of the Milanese Cathedral. Although some believe it to be a portrait of Gaffurio, others think the subject of the portrait is the famous Leonardo da Pistoia of the court of Cosimo de' Medici, painted after his discovery of the Corpus Hermeticus.

The musician is depicted holding a piece of paper, which is a musical score with notes written upon it. The man is positioned in a three-quarter position and he is staring at something outside the spectator's field of vision. Compared to the detailed face of the musician, the red hat, his tunic and his hair seem to be the work of another painter. Art historians have conceded that the quality of the depiction of the young man's face points towards Leonardo's own composition, though the partition sheet and his hand may have been added by another artist.





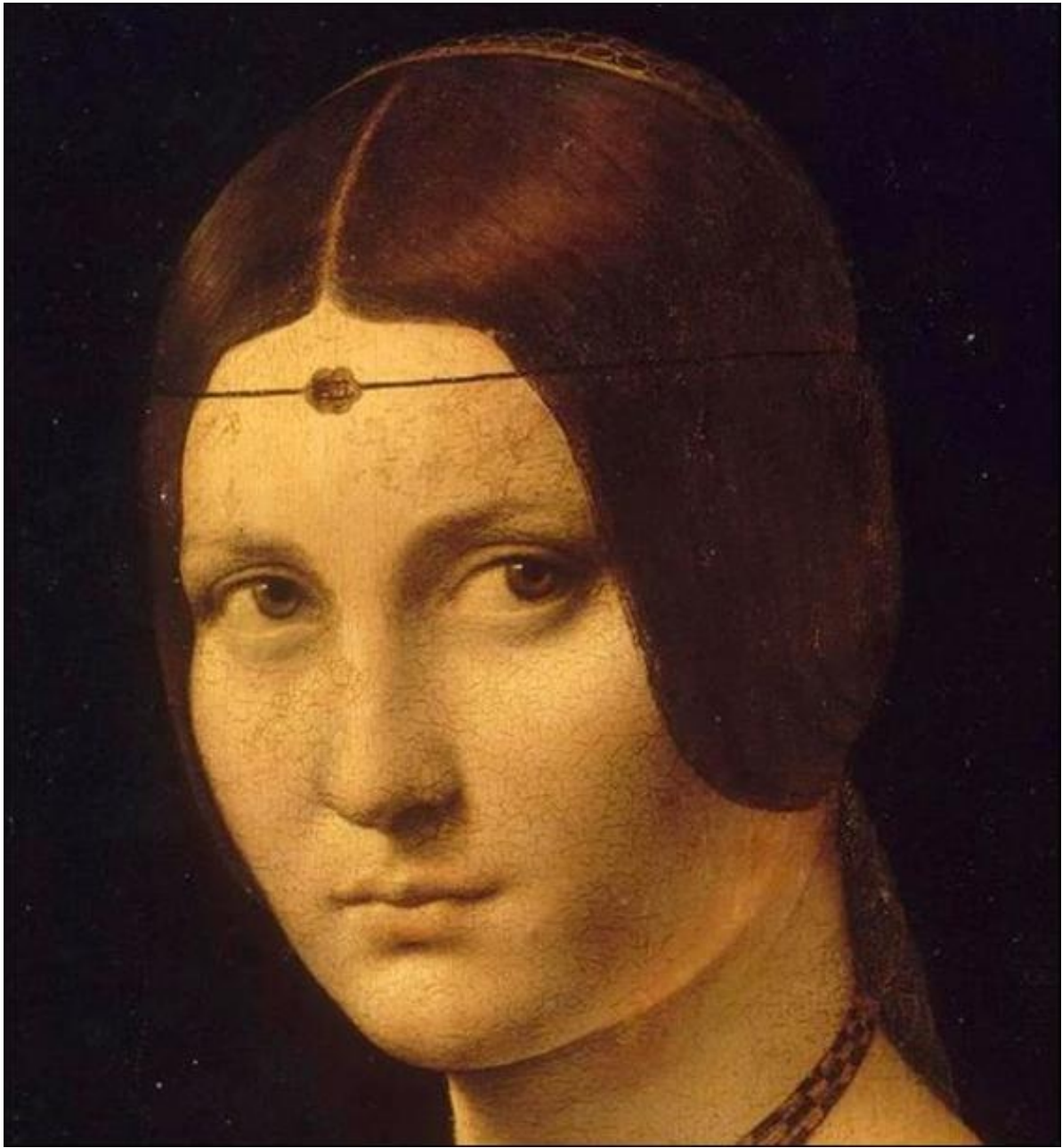
Detail

LA BELLE FERRONNIÈRE



This portrait of a young woman is housed in the Louvre and is traditionally attributed to Leonardo. The painting's title, applied as early as the seventeenth century, identifies the sitter as the wife or daughter of an ironmonger (a *ferronnier*). Some historians believe the title alludes to a reputed mistress of Francis I of France, who was married to a certain Le Ferron. According to a Romantic legend of revenge, the aggrieved husband Francis intentionally infected himself with syphilis, which he passed to the king through infecting his wife.





Detail



Detail

THE LAST SUPPER



This mural painting in Milan was created for Leonardo's patron Duke Ludovico Sforza and his duchess Beatrice d'Este. It represents the scene of The Last Supper from the final days of Jesus as it is told in the Gospel of John 13:21, when Christ announces that one of his disciples will betray him. All twelve apostles display different reactions to the pronouncement, with various degrees of anger and shock.

The Last Supper measures 450 × 870 centimetres and covers an end wall of the dining hall at the monastery of Santa Maria delle Grazie. The subject of the work was a traditional choice for refectories, although the room was not a refectory at the time that Leonardo painted it. The main church building had only recently been completed, but was remodelled by Bramante, who was hired by Ludovico Sforza to build a Sforza family mausoleum. The mural was commissioned by Sforza to be the centrepiece of the mausoleum and so Leonardo began work on *The Last Supper* in 1495, completing the painting by 1498, though he did not work on it continuously.

In the image, Judas Iscariot, Peter and John form one group of three figures, with Judas wearing green and blue, whilst being depicted in shadow, looking withdrawn and taken aback by the sudden revelation of his secret. He is clutching a small bag, signifying the silver given to him as payment to betray Jesus or perhaps it is a reference to his role within the twelve disciples as the treasurer. He is also tipping over the salt shaker. This may be related to the near-Eastern expression to "betray the salt", meaning to betray one's Master. He is the only person to have his elbow on the table and his head is also horizontally the lowest of anyone in the work. Peter looks angry and is holding a knife pointed away from Christ, perhaps foreshadowing his violent reaction in Gethsemane during Jesus' arrest. The youngest apostle, John, appears to swoon.

In common with other depictions of the subject from this period, Leonardo seats the diners on one side of the table, so that none of them have their backs to the viewer. Most previous depictions excluded Judas by placing him alone on the opposite side of the table from the others or placing halos around all the disciples, except for Judas. Leonardo instead depicts Judas as leaning back into shadow. Jesus is predicting that his betrayer will take the bread at the same time he does to Saints Thomas and James to his left, who react in horror as Jesus points with his left hand to a piece of bread before them. Distracted by the

conversation between John and Peter, Judas reaches for a different piece of bread not noticing Jesus too stretching out with his right hand towards it. The angles and lighting draw attention to Jesus, whose head is located at the vanishing point of all perspective lines.

Leonardo painted *The Last Supper* on a dry wall rather than on wet plaster, so the work is not a true fresco. Since a fresco cannot be modified as the artist works, Leonardo instead chose to seal the stone wall with a layer of pitch, gesso and mastic, followed by paint on the sealing layer with tempera. Due to the method used, the piece began to deteriorate a few years after Leonardo finished the painting and it now appears somewhat unfinished. As early as 1517 the painting was starting to flake. By 1556, fewer than sixty years after it was finished, Leonardo's biographer Giorgio Vasari described the painting as already "ruined" and so deteriorated that the figures were unrecognisable. In 1652 a doorway was cut through the (then unrecognisable) painting, and later bricked up. The doorway can still be seen as the irregular arch shaped structure near the centre base of the painting.

It is believed, from studying early copies, that Jesus' feet were in a position symbolising the forthcoming crucifixion. In 1768 a curtain was hung over the painting for the purpose of protection; it instead trapped moisture on the surface, causing further damage. During World War II, on August 15, 1943, the refectory building was struck by a bomb. Though protective sandbagging prevented the painting from being struck by bomb splinters, it may have been damaged further by the vibration of the attack.





Detail — Judas on left, holding his pouch of coins



Detail



Christ at the centre



Santa Maria delle Grazie church and Dominican convent in Milan, which contains The Last Supper. The church is now one of Milan's most popular tourist destinations, due to fame of Leonardo's mural.



This photo shows the bombing damage in 1943

THE MADONNA OF THE YARNWINDER



Created circa 1501, this is the subject of several oil paintings, of which the original version by Leonardo may now be lost. The composition depicts the Virgin Mary with the Christ child, who looks longingly at a yarnwinder used to gather spun yarn. The yarnwinder serves as a symbol of Mary's domesticity and the Cross on which Christ would be crucified, as well as suggesting the Fates, who are known in classical mythology as spinners of fortune.

At least three versions of the painting are in private collections. The original painting was presumably commissioned by Florimund Robertet, the Secretary of State for King Louis XII of France. The version of this painting often regarded as the most likely to be by Leonardo is now in the National Gallery of Scotland in Edinburgh, on loan from the Duke of Buccleuch. It hung in his home in Drumlanrig Castle, Dumfries and Galloway, Scotland until it was stolen in 2003 by two thieves posing as tourists. The painting was recovered at a lawyer's office in Glasgow in October 2007 after police officers, from four anti-crime agencies, raided a meeting of five people. A spokesman for the law firm said: "There is absolutely no impropriety whatsoever. There is an interesting, but benign, explanation, but no wrongdoing has been done on their part." Four arrests were made, including two solicitors from different firms. The Glasgow firm was reputed as being one of the country's most successful and respected law firms, which claimed it was acting as a go-between for two parties to secure legal repatriation of the painting from an unidentified party. John Scott, 9th Duke of Buccleuch had died just a month before the recovery. Following its dramatic recovery, the painting has been loaned to the National Gallery of Scotland in Edinburgh where it is currently on display.





Detail



Detail



A copy housed in a private collection in the US

MONA LISA



This portrait is quite simply the most famous work of art in the world. Also known as *La Gioconda*, it was painted in oil on a poplar panel and completed by 1519. It is a half-length portrait, depicting a seated woman, Lisa del Giocondo, a member of the Gherardini family of Florence and the wife of a wealthy Florentine silk merchant. The painting was commissioned for their new home and to celebrate the birth of their second son. In the painting, the ambiguity of Lisa's expression, the monumentality of the composition and the subtle handling of forms have all leant to the celebrity of this famous work of art, which is on permanent display at the Louvre in Paris

Leonardo began painting *Mona Lisa* in 1503 or 1504 in Florence, working occasionally on the piece for four years, before moving to France. He worked intermittently on the painting for another three years, finishing it shortly before he died in 1519. Most likely through the heirs of Leonardo's assistant Salai, the king bought the painting for 4,000 écus and kept it at Château Fontainebleau, where it remained until given to Louis XIV, who moved it to the Palace of Versailles. After the French Revolution, it was relocated to the Louvre. Napoleon I had the portrait moved to his personal bedroom in the Tuileries Palace, but it was later returned to the Louvre.

Leonardo used a pyramid design to place his subject simply in the space of the painting. Her folded hands form the front corner of the pyramid. Her breast, neck and face glow in the same light that covers her hands. The light gives the different parts of her skin an underlying impression of life. The woman sits markedly upright with her arms folded, which is also a sign of her reserved posture. Her gaze seems to address us with a silent communication. The brightly lit face is practically framed with much darker elements, such as the sitter's hair, veil and the surrounding shadows, contrasting strongly with the radiant quality of her face. The woman appears alive due to Leonardo's use of *sfumato*, not drawing the outlines of the mouth and other parts of the face, but softening them instead with a smooth appearance.

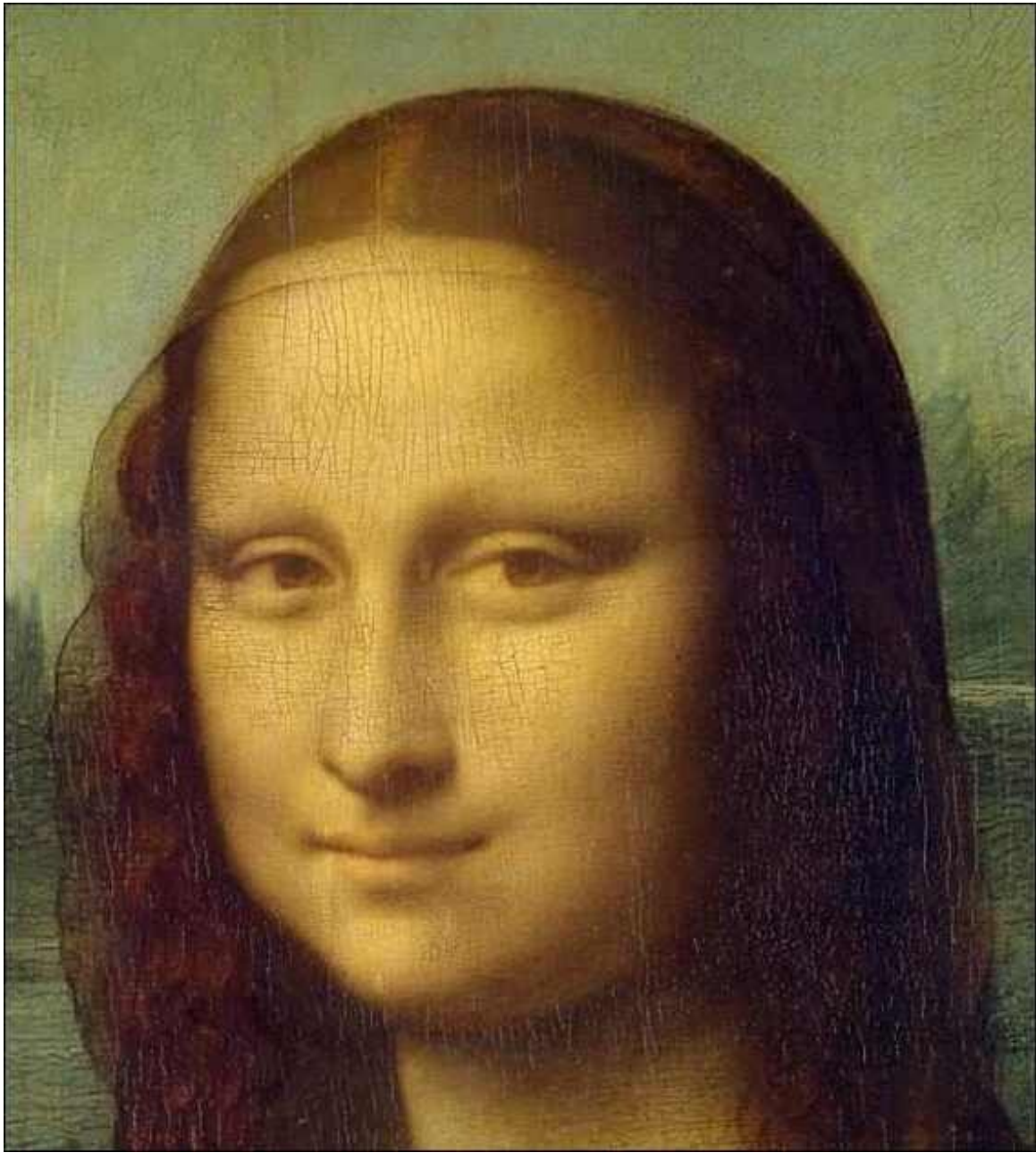
The enigmatic Lisa is portrayed seated in what appears to be an open loggia, with dark pillar bases on either side. Behind her a vast landscape recedes to icy mountains. Winding paths and a distant bridge give only the slightest indications of human presence. The sensuous curves of the woman's hair and clothing are echoed in the undulating imaginary valleys and rivers behind her. The blurred

outlines, graceful figure, dramatic contrasts of light and dark, and overall feeling of calm are characteristic of the artist's style. However, the landscape presented is in fact an 'impossible' landscape. The land on the right-hand side is much higher than the land on the left-hand side, which instead features a small lake. It has been argued that whilst a viewer switches their gaze between both sides of this 'impossible' landscape, it appears that the Mona Lisa moves or smiles, due to change of perspective.

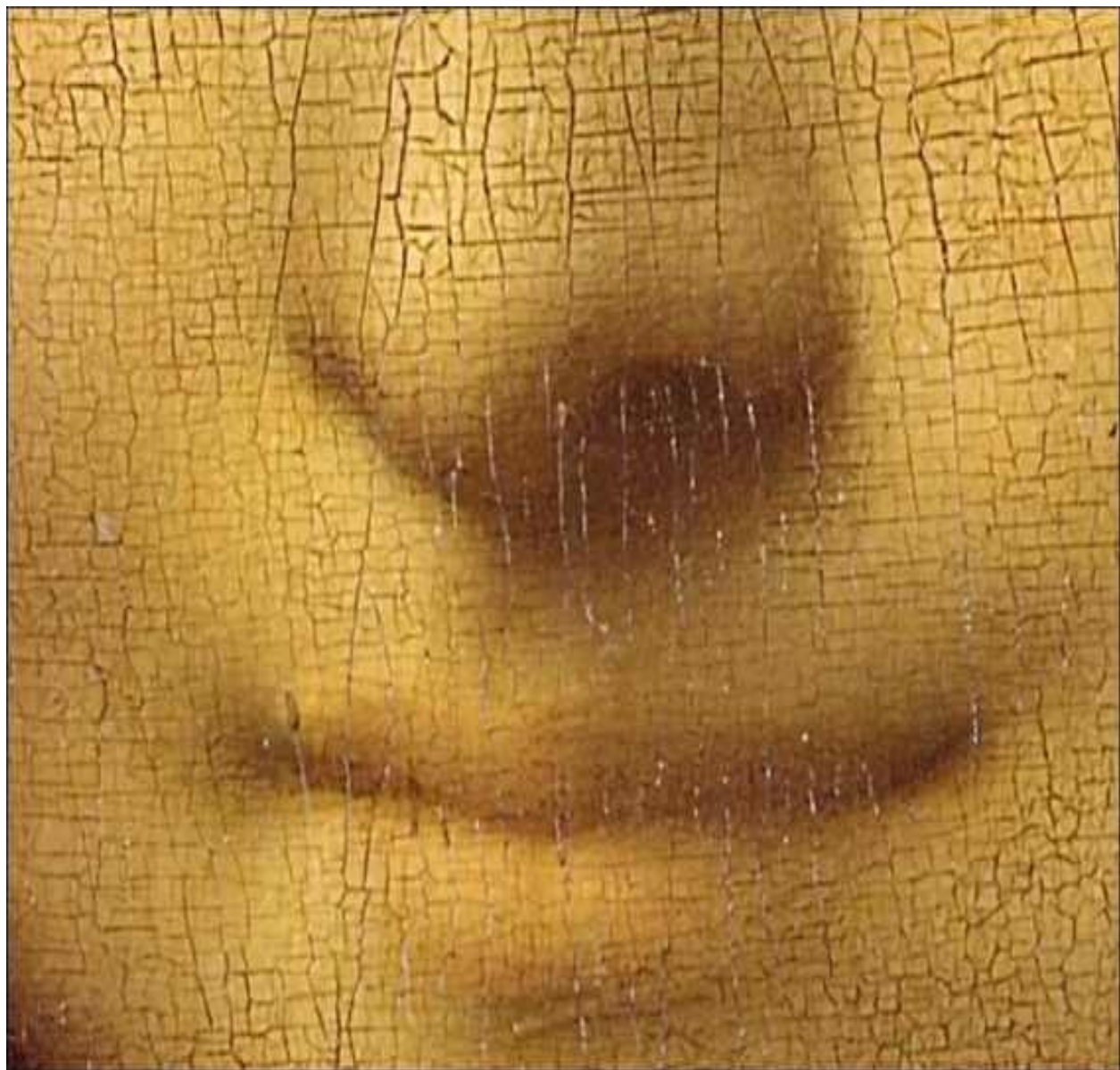
The *Mona Lisa* was not well known until the mid-19th century, when artists of the emerging Symbolist movement began to appreciate the portrait, associating it with their ideas of feminine mystique. The portrait was stolen on 21 August 1911 and the Louvre was closed for an entire week to aid the investigation of the theft. French poet Guillaume Apollinaire, who had once called for the Louvre to be burnt down, was arrested and put in jail. Apollinaire tried to implicate his friend Pablo Picasso, who was also brought in for questioning, but both were later released and exonerated. At the time, the painting was believed to be lost forever, and it was two years before the real thief was discovered. Louvre employee Vincenzo Peruggia had stolen it by entering the building during regular hours, concealing himself in a broom closet and walking out with it hidden under his coat after the museum had closed. Peruggia was an Italian patriot, who believed Leonardo's painting should be returned to Italy for display in an Italian museum. Peruggia may have also been motivated by a friend who sold copies of the painting, which would skyrocket in value after the theft of the original. After having kept the painting in his apartment for two years, Peruggia grew impatient and was finally caught when he attempted to sell it to the directors of the Uffizi Gallery in Florence. The painting was exhibited all over Italy and returned to the Louvre in 1913. Peruggia was hailed for his patriotism in Italy and served only six months in jail for the crime.

In 1956, the lower part of the painting was severely damaged when a vandal doused the painting with acid. On 30 December of that same year, a young Bolivian named Ugo Ungaza Villegas damaged the painting by throwing a rock at it. This resulted in the loss of a speck of pigment near the left elbow, which was later painted over. The use of bulletproof glass has shielded the Mona Lisa from more recent attacks. In April 1974, a handicapped woman, upset by the museum's policy for the disabled, sprayed red paint at the painting while it was on display at the Tokyo National Museum. On 2 August 2009, a Russian woman, distraught over being denied French citizenship, threw a terra cotta mug or teacup, purchased at the museum, at the painting in the Louvre. In both cases, the painting was undamaged.





Detail



Detail



Detail



Detail — left-hand landscape, featuring a small lake



The Isleworth Mona Lisa, housed in Switzerland in a private collection. Some claim that this is the earlier of two versions of the Mona Lisa, painted for Francesco del Giocondo in 1503, arguing that the Louvre version was painted for Giuliano de' Medici in 1517.

THE VIRGIN AND CHILD WITH ST. ANNE



This painting was commissioned as the high altarpiece for the Church of Santissima Annunziata in Florence and is now housed in the Louvre. It depicts St. Anne, her daughter the Virgin Mary and the infant Jesus. Christ is portrayed grappling with a sacrificial lamb, symbolising his Passion, as the Virgin attempts to restrain him. The Virgin Mother is sitting on St. Anne's lap and it is unclear what meaning Leonardo intended with that pose. There is no clear parallel in other works of art of women sitting in each other's lap.





Detail



Detail

LEDA AND THE SWAN



Leonardo began making studies in 1504 for a painting, apparently never executed, of the mythical Leda, the mortal mother of Helen of Troy, seated on the ground with her children. In 1508 he painted a different composition of the subject, with a nude standing Leda cuddling the Swan, with the two sets of infant twins and their huge broken egg-shells. The original of this is lost, probably deliberately destroyed, and was last recorded as being in the French royal Château de Fontainebleau in 1625 by Cassiano dal Pozzo. However, the work is known from many copies, of which the earliest is probably the Spiridon Leda, perhaps by a studio assistant and now housed in the Uffizi and the copy at Wilton House in Salisbury, England.



The Spiridon Leda, Uffizi Gallery, Florence



Detail



Detail



Another copy of Leonardo's painting, housed in Wilton House



Detail



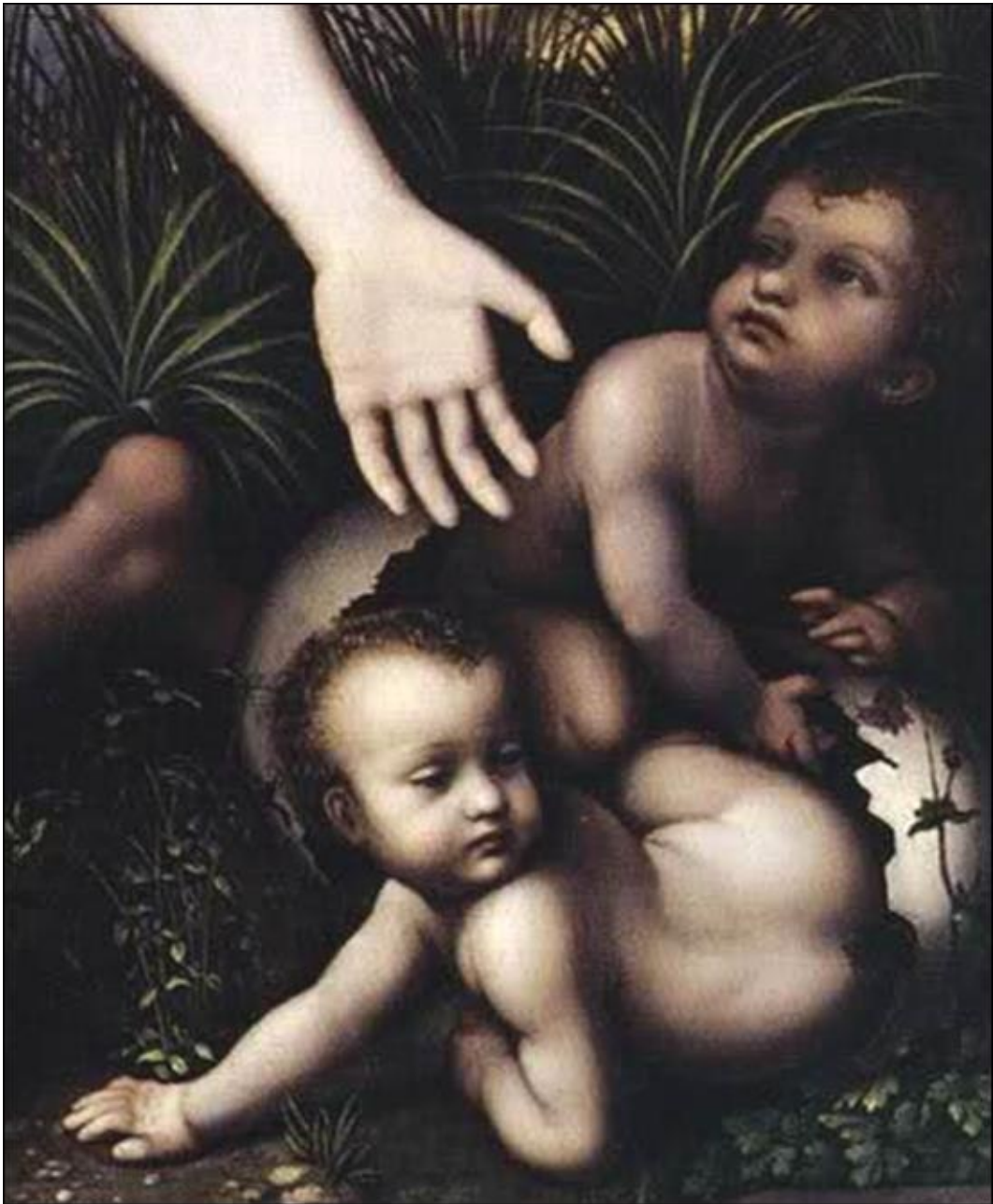
Detail



Another work inspired by Leonardo's original lost painting — this time by Giampietrino



Detail



Detail

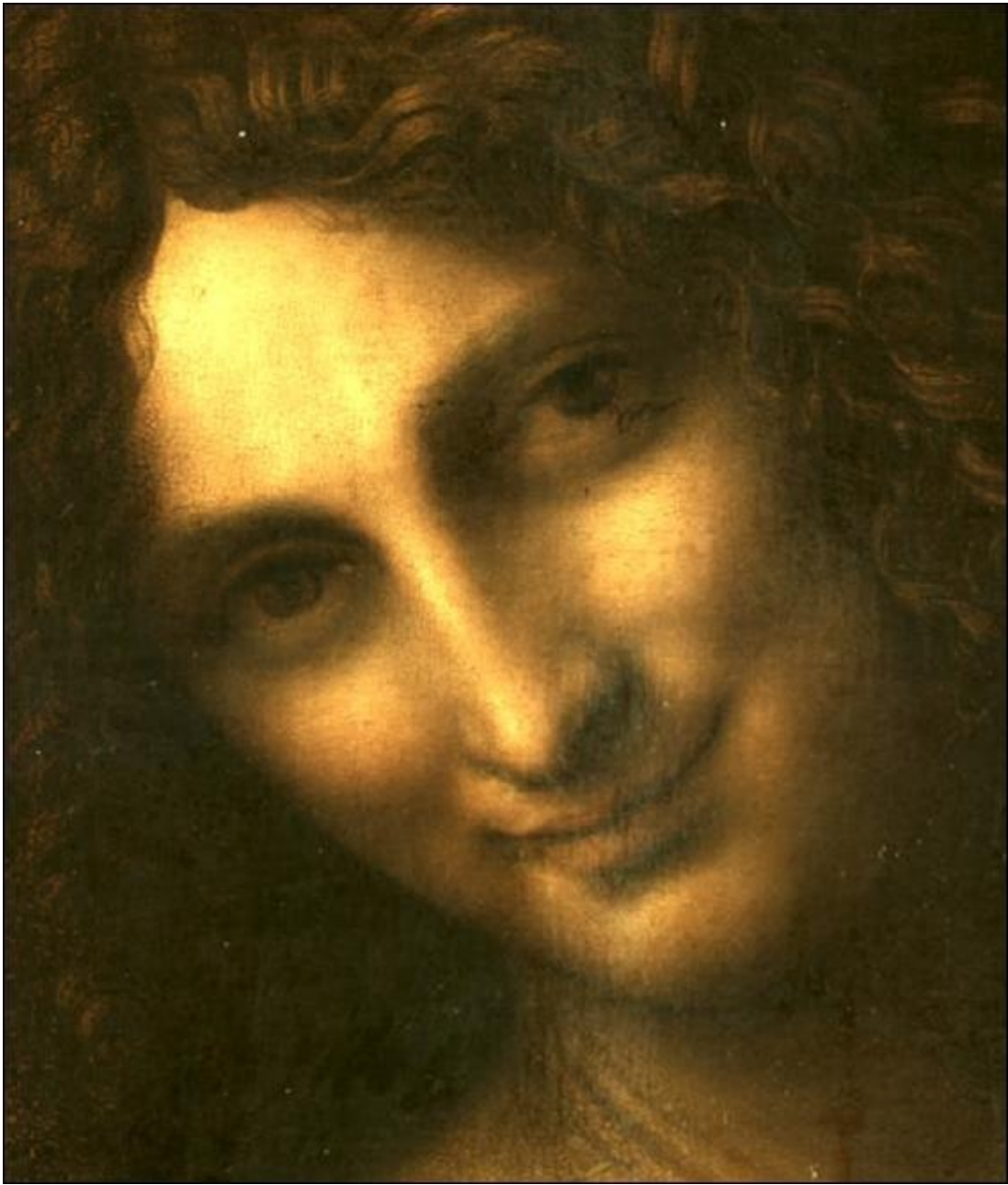
ST. JOHN THE BAPTIST



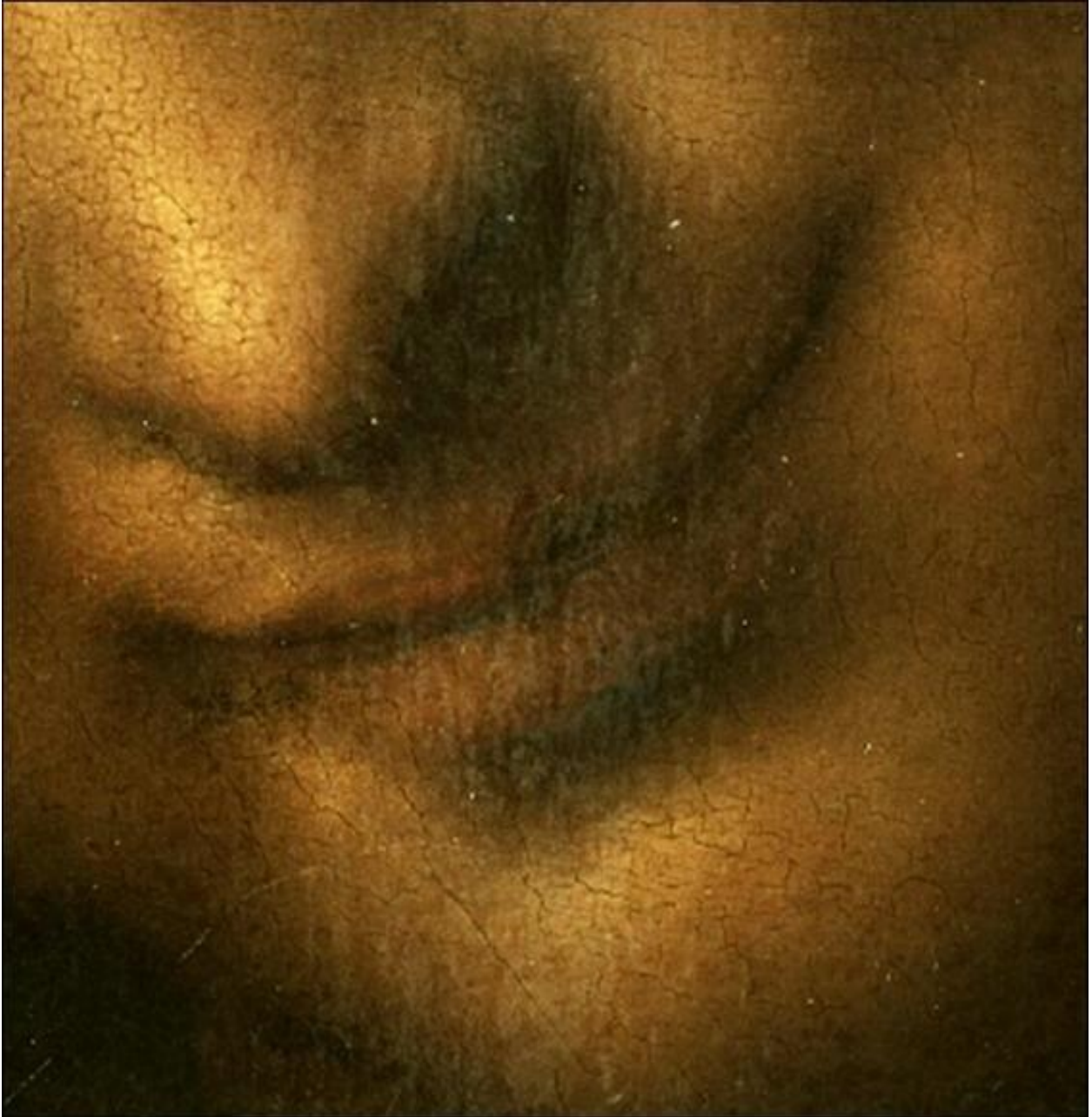
Completed in 1516, when High Renaissance art was shifting into Mannerism, this painting is believed to be Leonardo's last and is now housed in the Louvre. It depicts St. John the Baptist with long curly hair, alone in the dark and dressed in pelts. He bears an enigmatic smile, recalling once again the famous *Mona Lisa*. The saint holds a reed cross in his left hand, whilst his right hand points up towards heaven. It is believed that the cross and wool skins were added at a later date by another painter.

The pointing gesture of St. John toward the heavens suggests the importance of salvation through baptism, which this particular saint represents. The work produces an ambiguous and mysterious quality, as the gender of the subject appears uncertain and the smile on the saint's face comes across as almost demonic, causing an eerie confusion in its intended meaning.





Detail



Detail



Detail

BACCHUS (ST. JOHN THE BAPTIST)



Housed in the Louvre, this painting is based on a drawing by Leonardo. It is presumed to have been executed by an unknown follower, perhaps in the artist's workshop. The canvas depicts a male figure with a garlanded head and leopard skin, seated in an idyllic landscape. He points with his right hand off to his left, while with his left hand he grasps his thyrsus and points down to earth. The painting originally depicted John the Baptist, but in the late seventeenth century, it was altered to portray the mythical god Bacchus. The fur robe is the legacy of John the Baptist, but has been painted over with leopard-spots relating, like the wreath, to Bacchus, the Roman god of wine and revelry.





Detail

THE BATTLE OF ANGHIARI



This is the title of a lost painting by Leonardo. Its central scene depicted four men riding raging war horses engaged in a battle for possession of a standard at the Battle of Anghiari in 1440. Many preparatory studies by Leonardo still exist, but the work is best known through a drawing by the famous Dutch painter Peter Paul Rubens in the Louvre. Rubens' drawing, dating from 1603, was based on an engraving of 1553 by Lorenzo Zacchia, which was taken from Leonardo's painting itself or possibly derived from a cartoon by the artist.

In 1504 Leonardo was given the commission by Piero Soderini to decorate the Hall of Five Hundred. At the same time his rival Michelangelo, who had just finished his sculpture of David, was designated the opposite wall. This was the only time that Leonardo and Michelangelo worked together on the same project. The painting of Michelangelo depicted an episode from the Battle of Cascina, when a group of bathing soldiers was surprised by the enemy. However, Michelangelo did not stay in Florence long enough to complete the project. He was able to finish his cartoon, but only began the painting. He was invited back to Rome in 1505 by the newly appointed Pope Julius II and was commissioned to build the Pope's tomb.

Leonardo drew his large cartoon in the Basilica di Santa Maria Novella, depicting a scene from the life of Niccolò Piccinino, a condottiere in the service of duke Filippo Maria Visconti of Milan. He drew a scene of a violent clash of horses and a furious skirmish of men fighting for the flag in the Battle of Anghiari. Giorgio Vasari praised the magisterial way Leonardo had put this scene on paper: "It would be impossible to express the inventiveness of Leonardo's design for the soldiers' uniforms, which he sketched in all their variety, or the crests of the helmets and other ornaments, not to mention the incredible skill he demonstrated in the shape and features of the horses, which Leonardo, better than any other master, created with their boldness, muscles and graceful beauty."

Leonardo built an ingenious scaffold in the Hall of Five Hundred that could be raised or folded in the manner of an accordion. This painting was to be his largest and most substantial work. Since he had suffered an almost disastrous experience in fresco painting with *The Last Supper*, he wanted to apply oil colours on the wall. He began also to experiment with a thick undercoat, which after he applied the colours, the paint began to drip. Trying to dry the painting in

a hurry and save whatever he could, he hung large charcoal braziers close to the painting. Only the lower part could be saved in an intact state. But the upper part did not dry fast enough and the colours intermingled. Leonardo then abandoned the project.

Michelangelo and Leonardo's unfinished paintings adorned the same room together for almost a decade (1505-1512). The cartoon of Michelangelo's painting was cut in pieces by Bartolommeo Bandinelli out of jealousy in 1512. The centrepiece of *The Battle of Anghiari* was greatly admired and numerous copies were made for decades.

In the mid-16th century (1555-1572), the hall was enlarged and restructured by Vasari and his helpers, so that Grand Duke Cosimo I could hold his court in the chamber. During this transformation, several famous, but unfinished works were lost, including *The Battle of Cascina* by Michelangelo and *The Battle of Anghiari* by Leonardo.



Rubens' copy of 'The Battle of Anghiari'



Detail



Detail



Detail

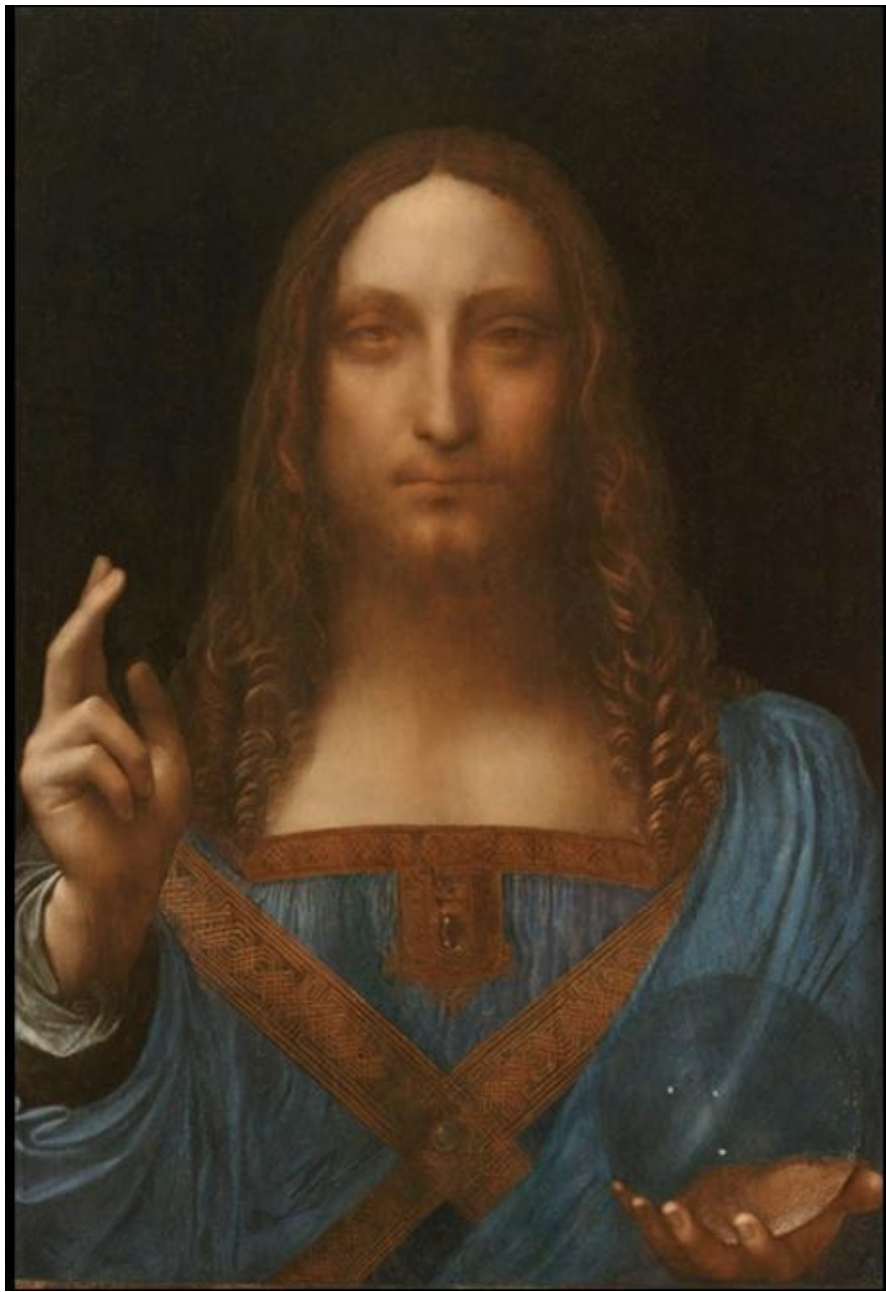


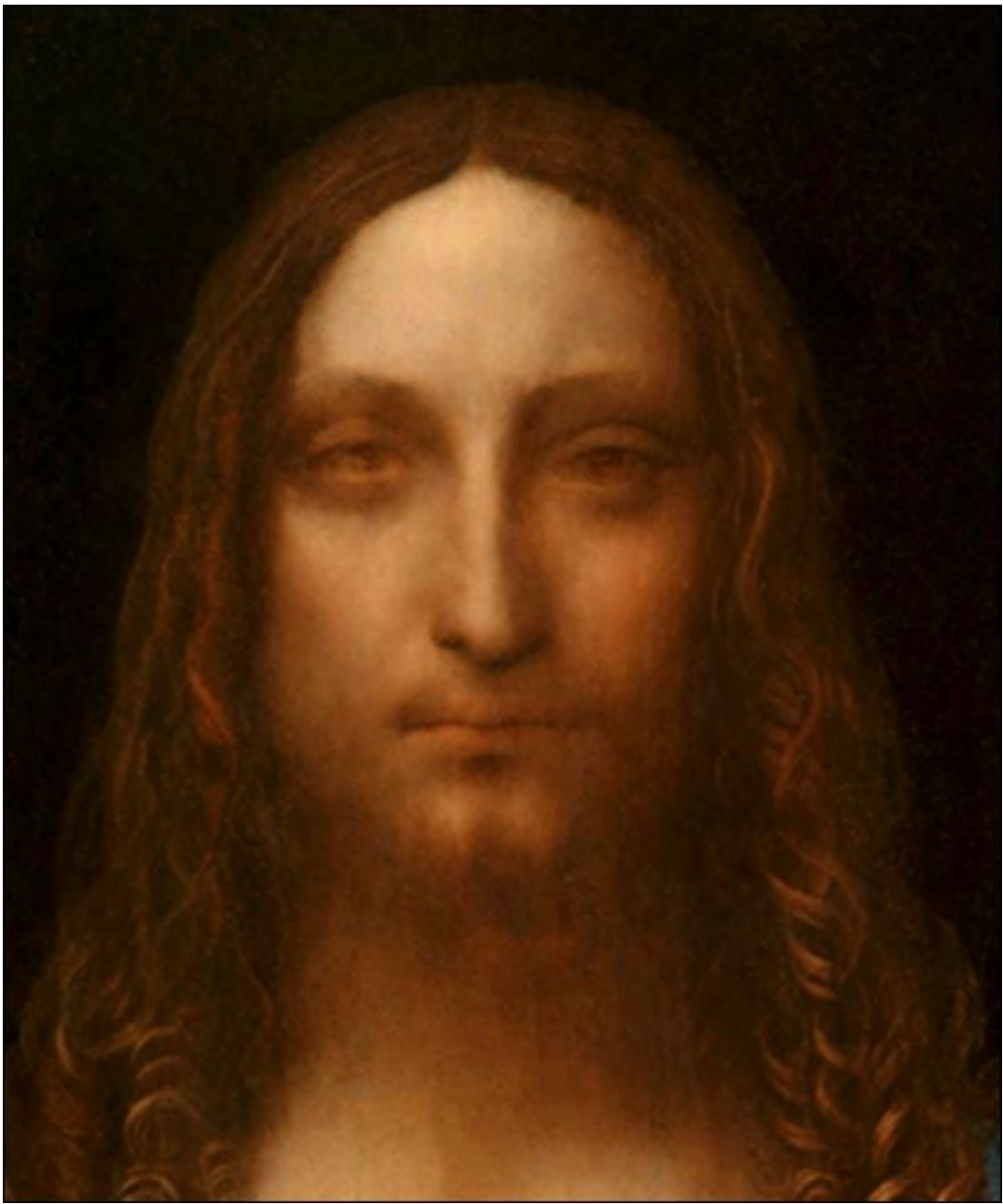
A drawing by Leonardo as a study for 'The Battle of Anghiari'

SALVATOR MUNDI



This work was lost, but later rediscovered and restored in 2011. The title translates as ‘Saviour of the World’ and depicts Christ giving a benediction. Leonardo painted the subject in France for Louis XII between 1506 and 1513. The recently authenticated work was once owned by King Charles I and recorded in his art collection in 1649, before being auctioned by the son of the Duke of Buckingham in 1763. The canvas next appeared in 1900, damaged from previous restoration attempts and its authorship unclear, when it was purchased by a British collector, Sir Frederick Cook. Cook’s descendants sold the painting at auction in 1958 for £45. *Salvator Mundi* was rediscovered and acquired by a US consortium of art dealers in 2005, who authenticated the work as being by Leonardo. It was exhibited by London’s National Gallery during the *Leonardo da Vinci: Painter at the Court of Milan* from November 2011 to February 2012.





Detail

PORTRAIT OF A LADY IN PROFILE



Housed in the Pinacoteca Ambrosiana in Milan, this portrait is generally attributed to Ambrogio de Predis, though the face is thought by some to show the hand of Leonardo.





Detail

MADONNA AND CHILD WITH ST. JOSEPH



This tempera on panel work, now housed in the Galleria Borghese in Rome, was previously attributed to Fra Bartolomeo. However, after recent cleaning, the Borghese Gallery sought attribution as a work of Leonardo's youth, based on the discovery of a fingerprint similar to one that appears in *The Lady with the Ermine*. The true identity of the artist is still unresolved.



The Drawings



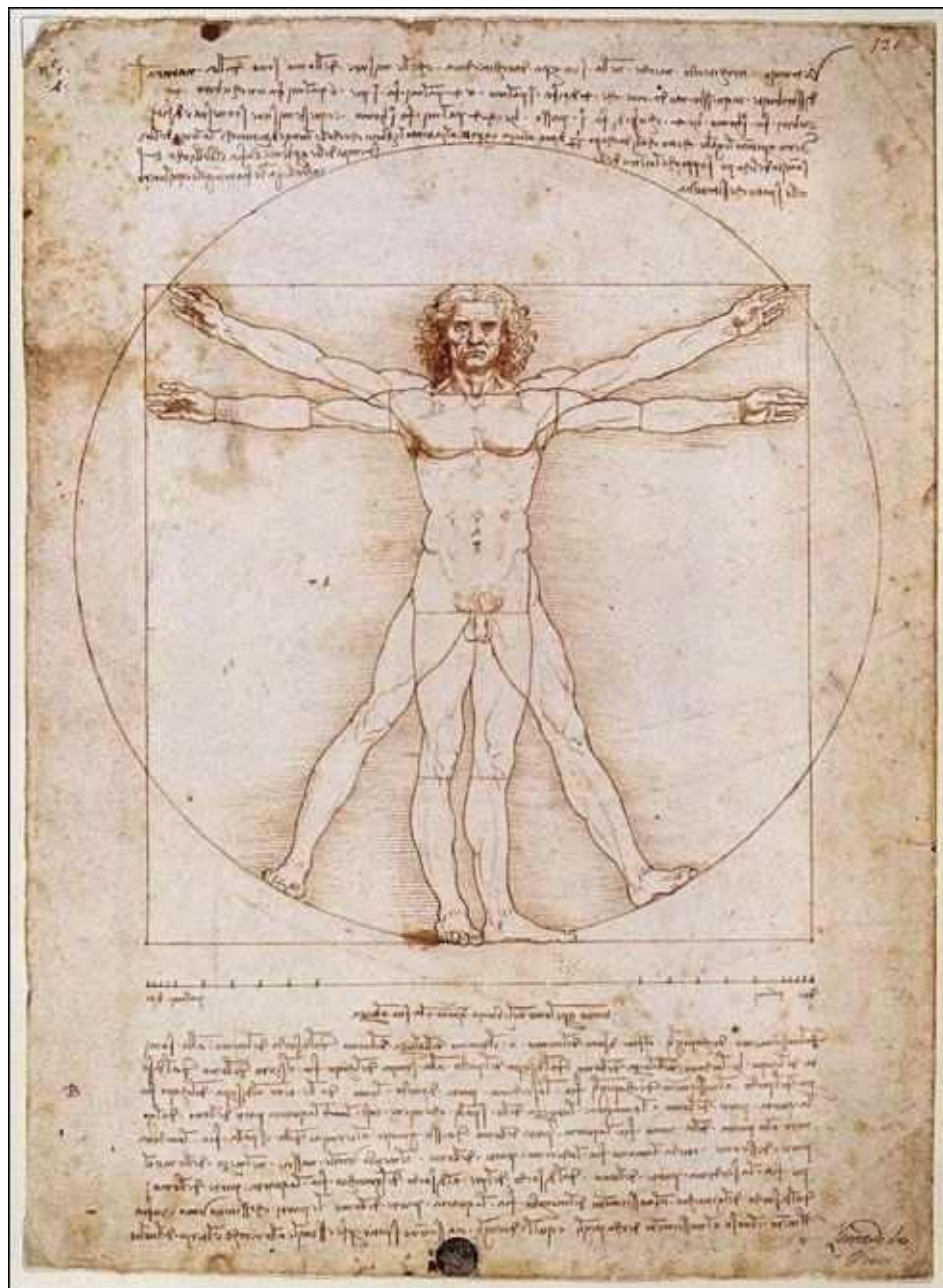
Leonardo's earliest known drawing, depicting the Arno Valley (1473), housed in the Uffizi, Florence

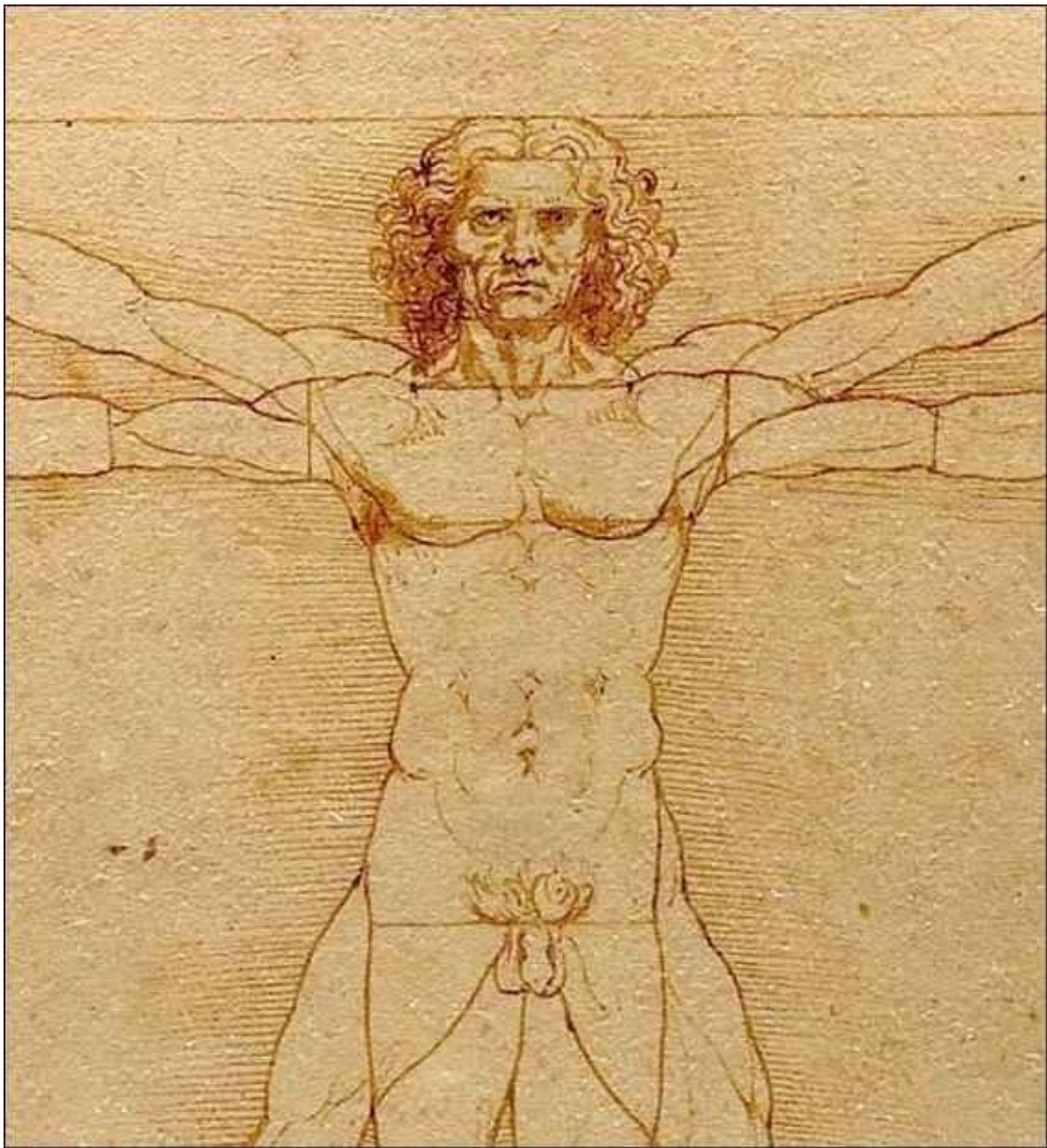
THE VITRUVIAN MAN



This famous drawing was created circa 1487, accompanied with notes based on the work of the famed architect Vitruvius. The drawing was made in pen and ink on paper, depicting a male figure in two superimposed positions with his arms and legs apart and simultaneously inscribed in a circle and square. The drawing and text are sometimes called the 'Canon of Proportions'. Housed in the Gallerie dell'Accademia in Venice, it is only occasionally displayed. The drawing is based on the correlations of ideal human proportions with geometry described by the ancient Roman architect Vitruvius in Book III of his treatise *De Architectura*. Vitruvius described the human figure as being the principal source of proportion among the Classical orders of architecture.

This image exemplifies the blend of art and science during the Renaissance and provides the perfect example of Leonardo's keen interest in proportion. In addition, this picture represents a cornerstone of Leonardo's attempts to relate man to nature.





Detail

THE VIRGIN AND CHILD WITH ST. ANNE AND ST. JOHN THE BAPTIST



Housed in the National Gallery, London, this drawing is believed to have been completed by 1500, drawn in charcoal and black and white chalk, on eight sheets of paper glued together. Due to its large size and format the drawing is presumed to be a cartoon for a painting, though no painting exists that is based directly on the cartoon.

The drawing depicts the Virgin Mary seated on the knees of her mother St. Anne and holding the Child Jesus, while St. John the Baptist, the cousin of Jesus, stands to the right. The drawing is notable for its complex composition, demonstrating the alternation in the positioning of figures that is first apparent in Leonardo's paintings in the *Benois Madonna*. The knees of the two women point in different directions, with Mary's knees turning out of the painting to the left, while her body turns sharply to the right, creating a sinuous movement. The knees and the feet of the figures establish a strong up-and-down rhythm at a point in the composition where a firm foundation comprising firmly planted feet, widely spread knees and a broad spread of enclosing garment would normally be found. While the lower halves of their bodies turn away, the faces of the two women turn towards each other, mirroring each other's features. The delineation between the upper bodies has lost clarity, suggesting that the heads are part of the same body.





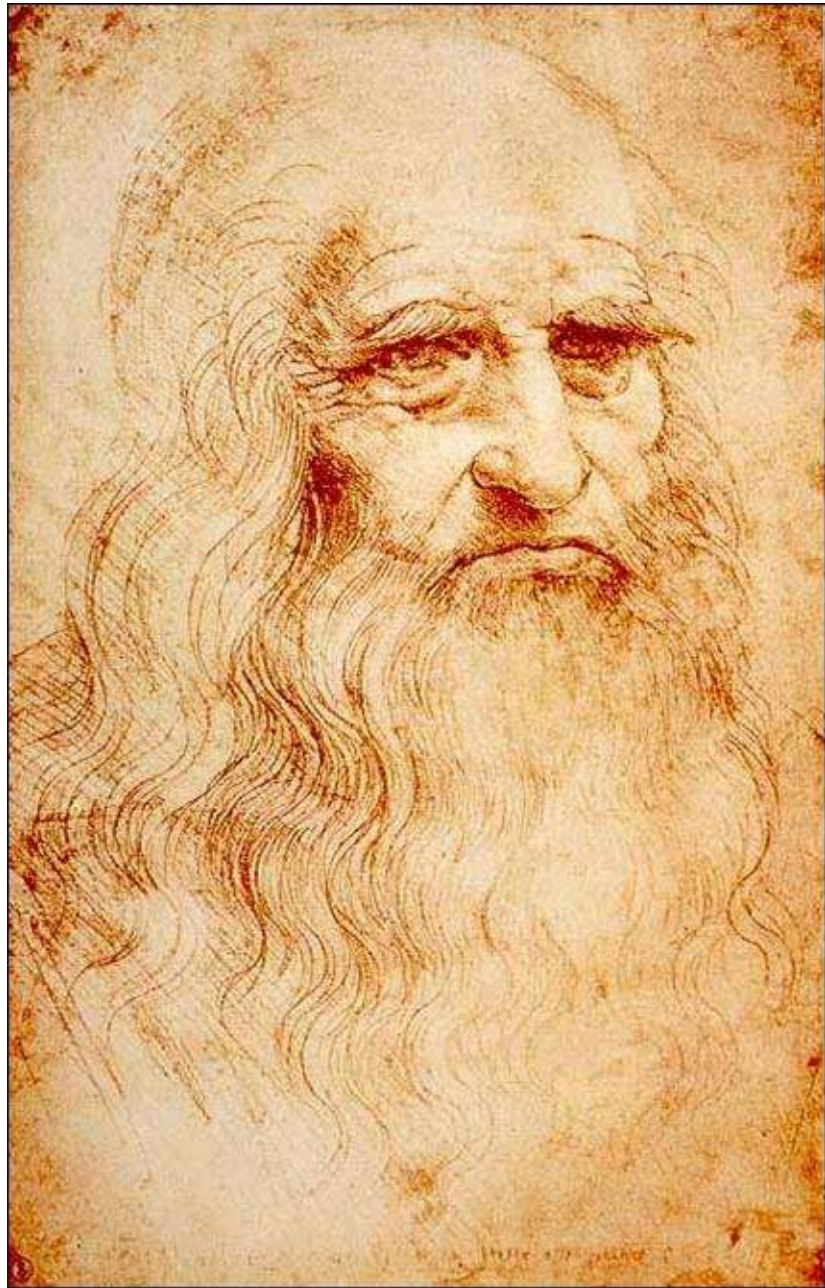
Detail

SELF-PORTRAIT



This drawing is widely accepted as a self-portrait of Leonardo, which he drew at approximately the age of 60. The portrait is drawn in red chalk on paper, depicting the head of an elderly man in three-quarter view, turned towards the viewer's right. The subject is distinguished by his long hair and long waving beard, which flow over the shoulders and breast. The length of the hair and beard is uncommon in Renaissance portraits and suggests, as they still do now, a person of sagacity. The face has a somewhat aquiline nose and is marked by deep lines on the brow and pouches below the eyes. It appears as if the man has lost his upper front teeth, causing deepening of the grooves from the nostrils.

The drawing has been produced in fine lines, shadowed by hatching and executed with the left hand, as was Leonardo's habit. The paper has brownish "fox marks" caused by the accumulation of iron salts, due to the build-up of moisture over time. The drawing is housed in the Royal Library in Turin and is not generally viewable by the public due to its fragility and poor condition.



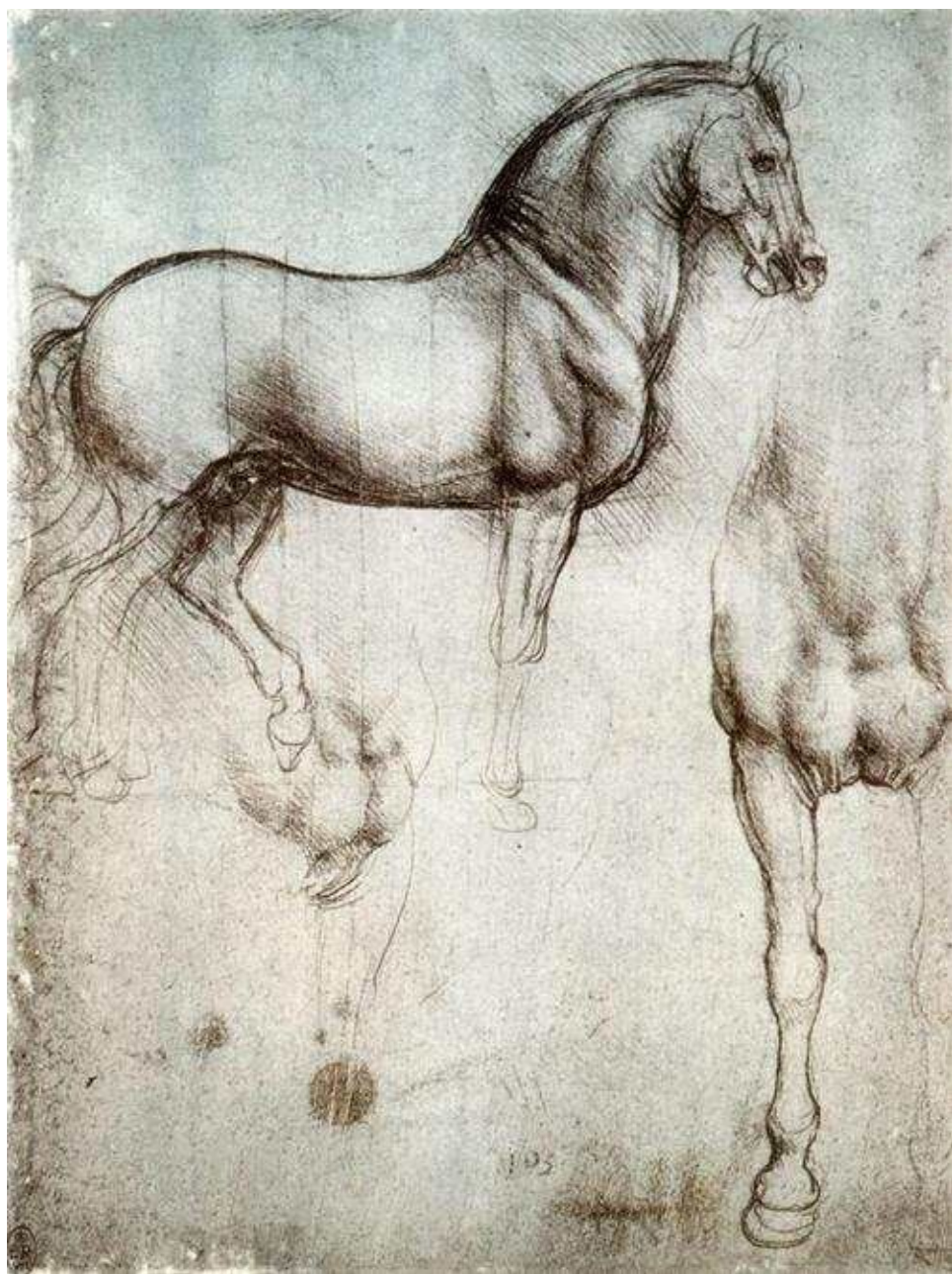


Detail

STUDY OF HORSES



Leonardo was commissioned to create a statue of a horse in 1482 by the Duke of Milan Ludovico il Moro, but the work was never completed. It was intended to be the largest equestrian statue in the world, a monument to the Duke's father Francesco. Leonardo did complete extensive preparatory work for the project, but he produced only a clay model, which was destroyed by French soldiers when they invaded Milan in 1499. About five centuries later, Leonardo's surviving design materials were used as the basis for sculptures intended to bring the project to life.





Leonardo's Horse, replica in Milan

OTHER DRAWINGS



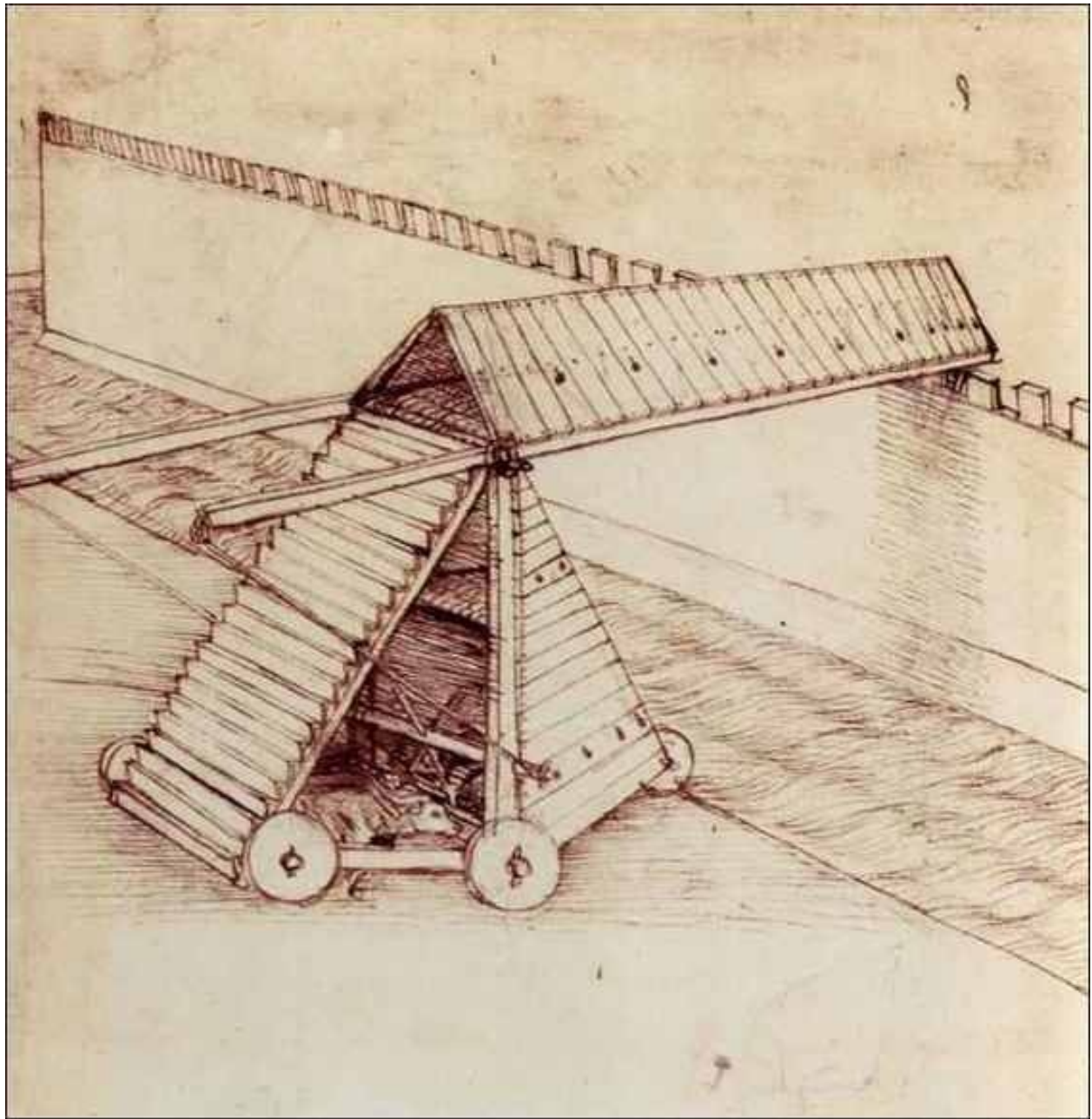
In this section there is a wide range of Leonardo's detailed drawings, demonstrating the diverse subjects he studied, as well as showcasing his consummate skill in depicting all aspects of human life and the natural world.



Study of Arms and Hands, c. 1474



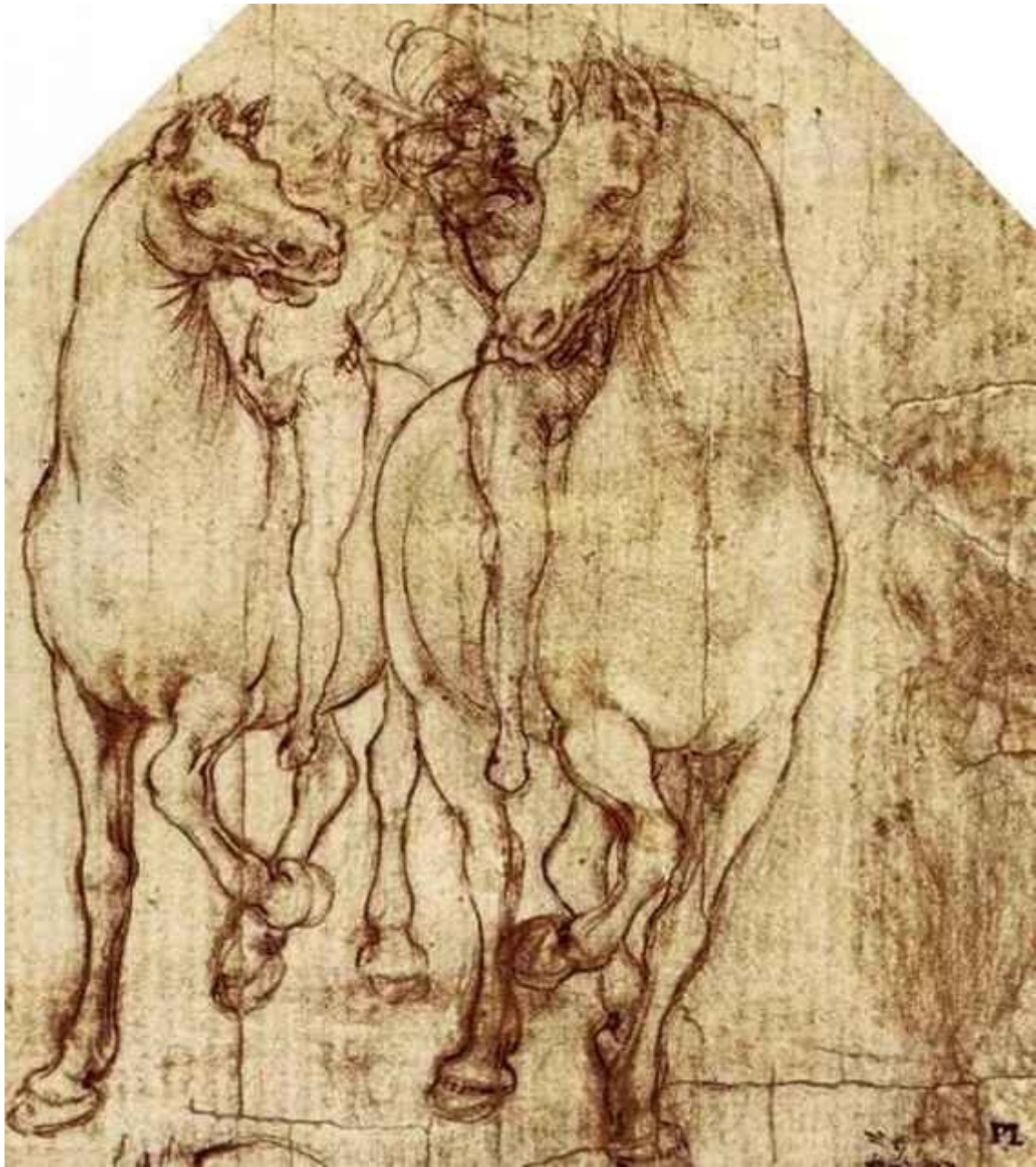
Man with a Staff, c. 1476-1480



Siege Machine, c. 1480



Saint Sebastian, c. 1480



Study of Horse and Rider, c. 1480



Study of Horse and Rider, c. 1481



Designs for a Boat, c. 1485-7



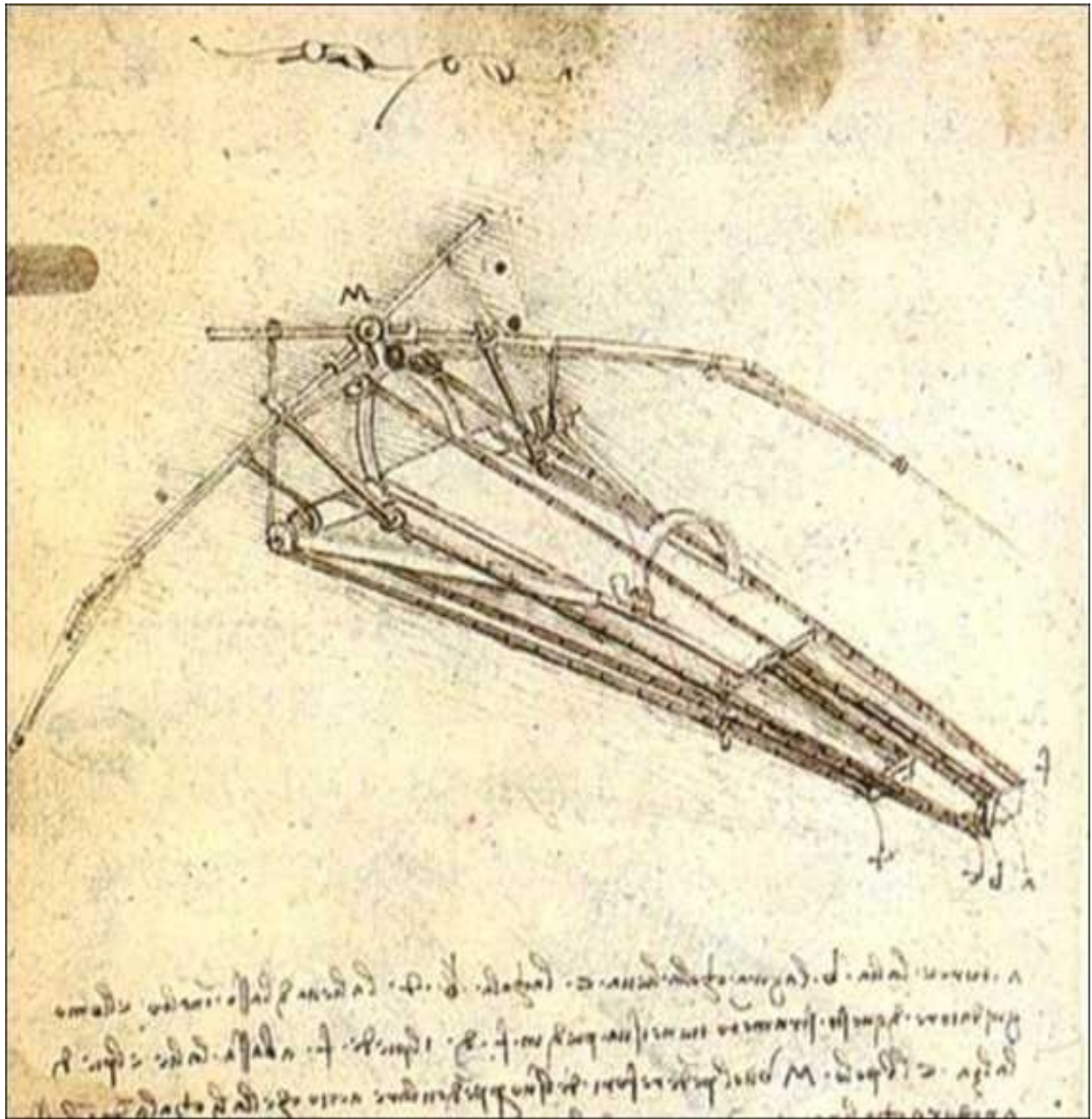
An Artillery Park, c. 1487



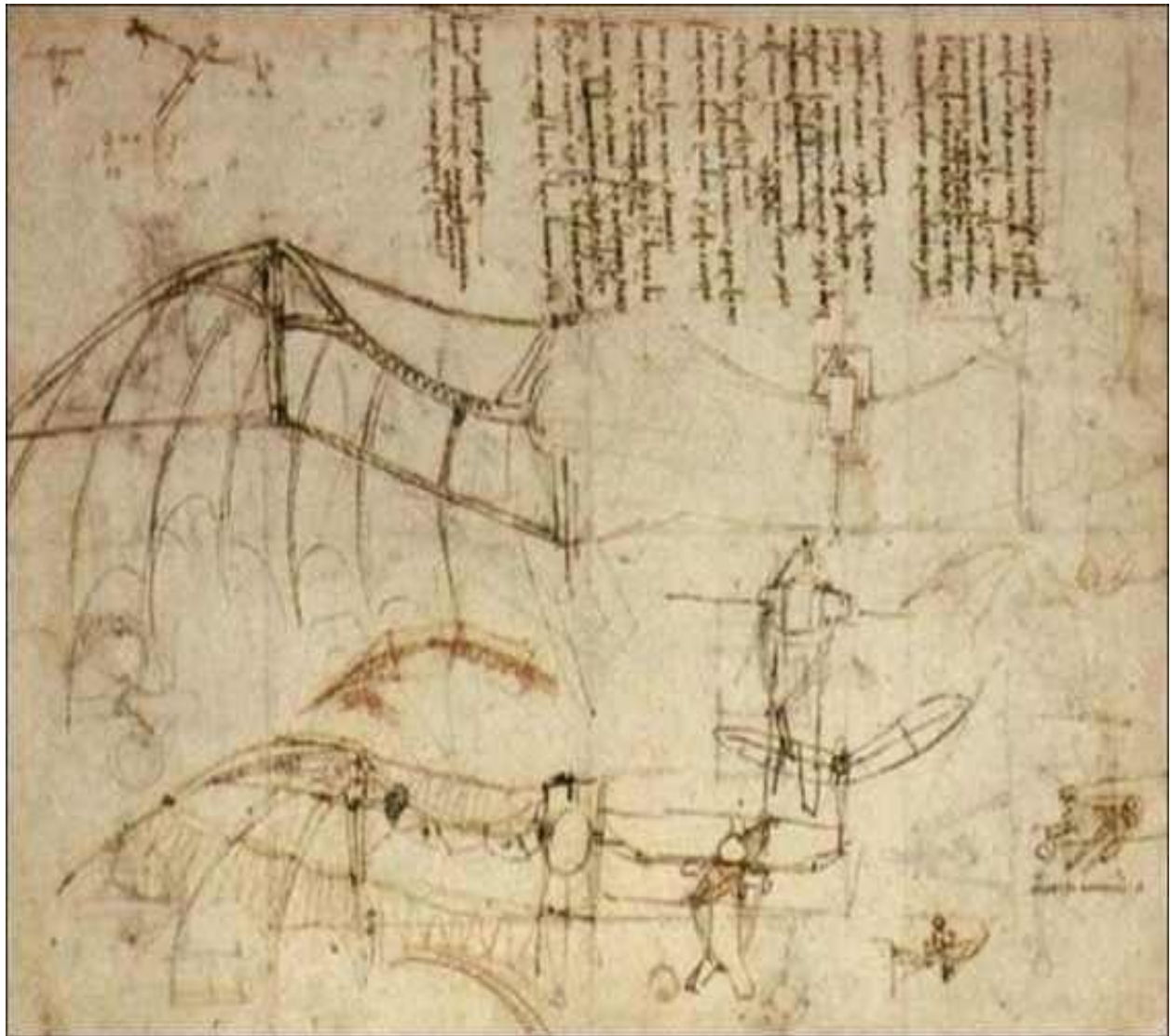
Study of a Young Woman in Profile, c. 1485-7



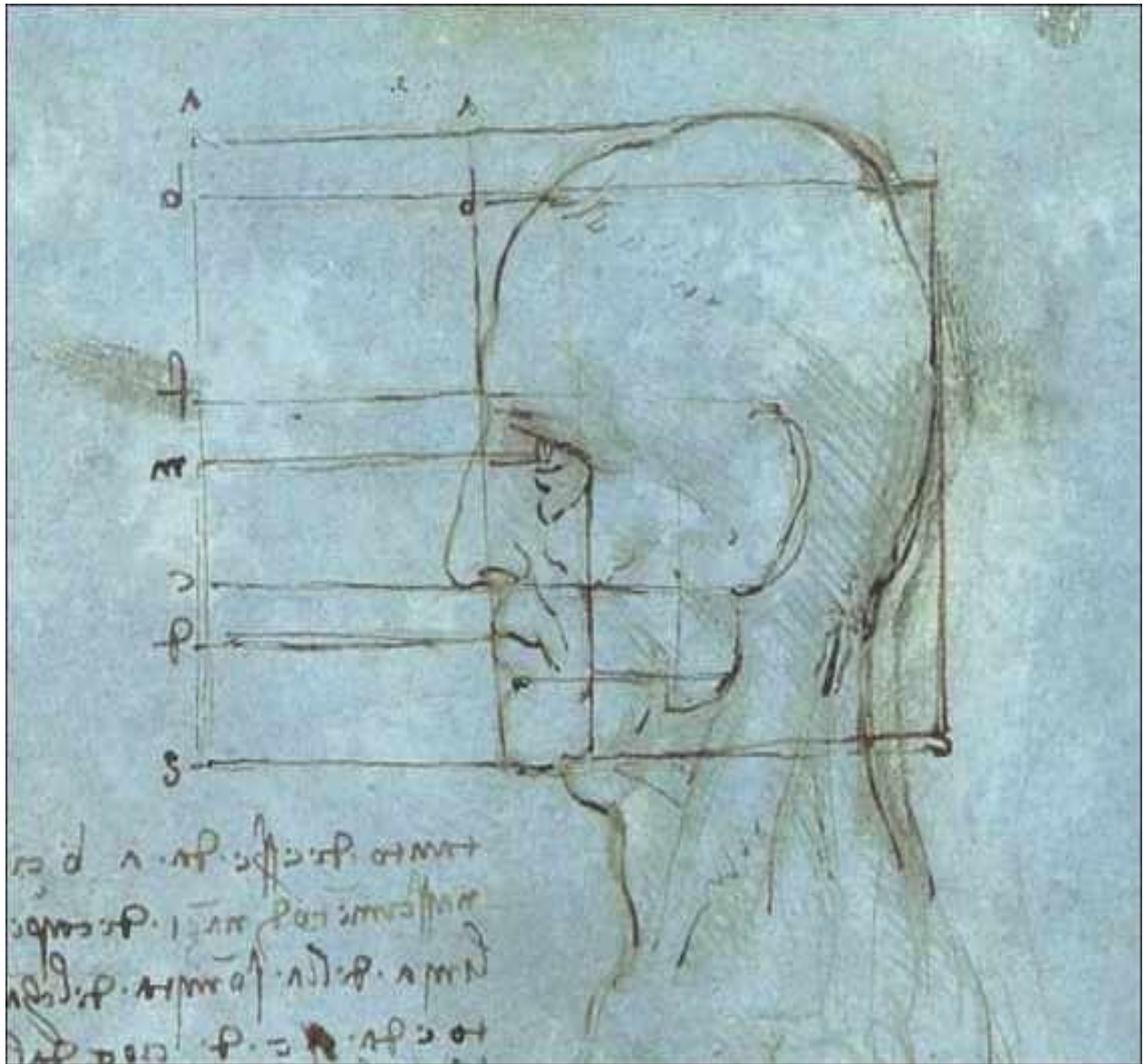
Grotesque Profile, c. 1487-90



Design for a Flying Machine, c. 1488



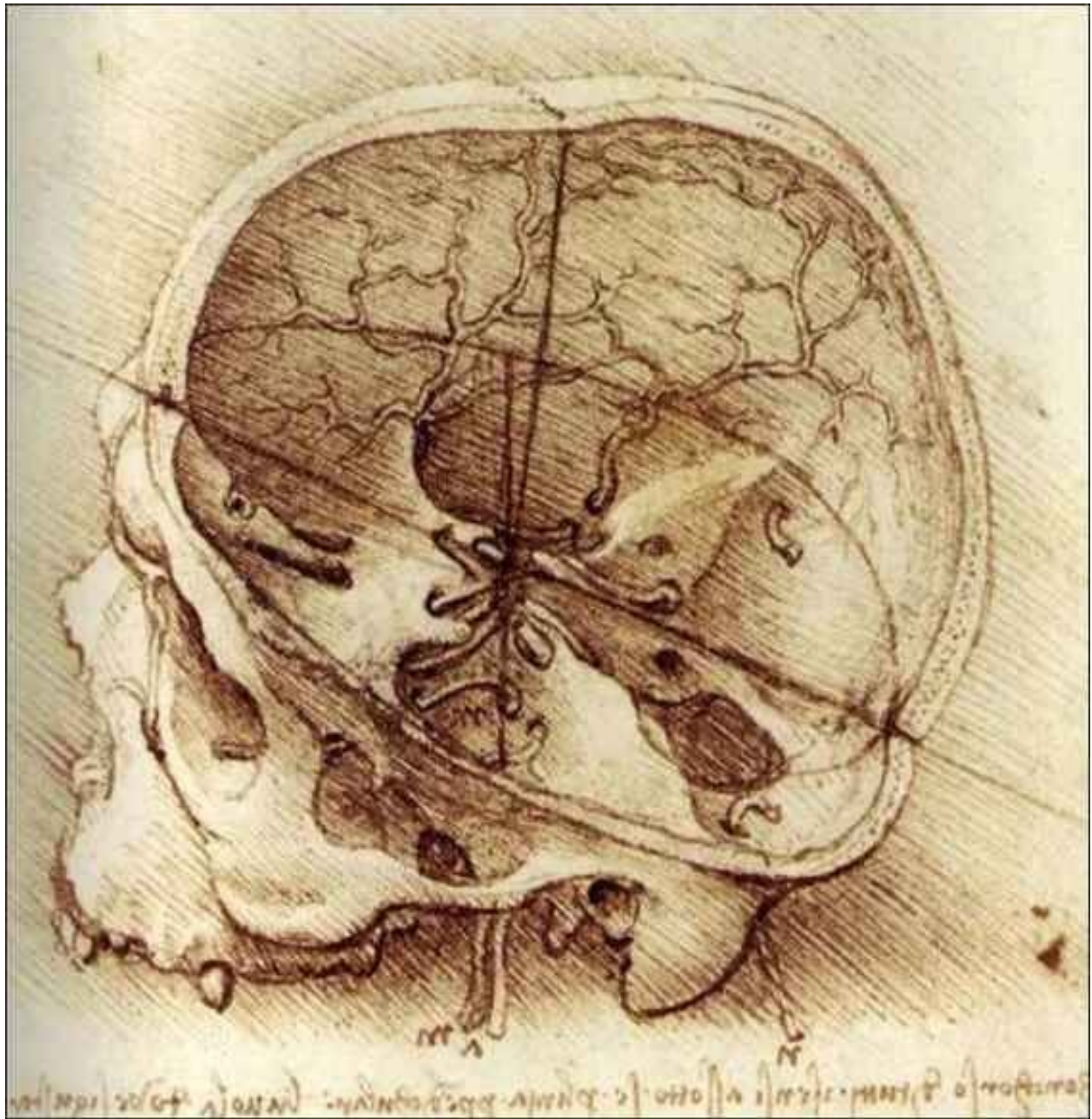
Design for a Flying Machine, c. 1488



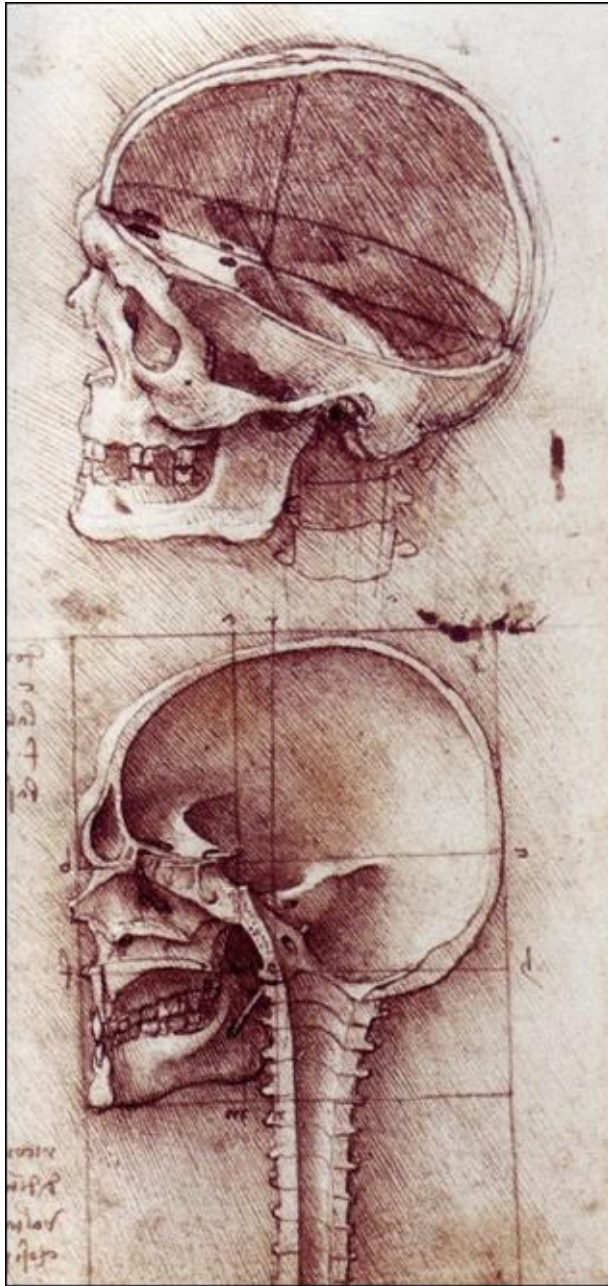
Proportions of the Head, c. 1488-9



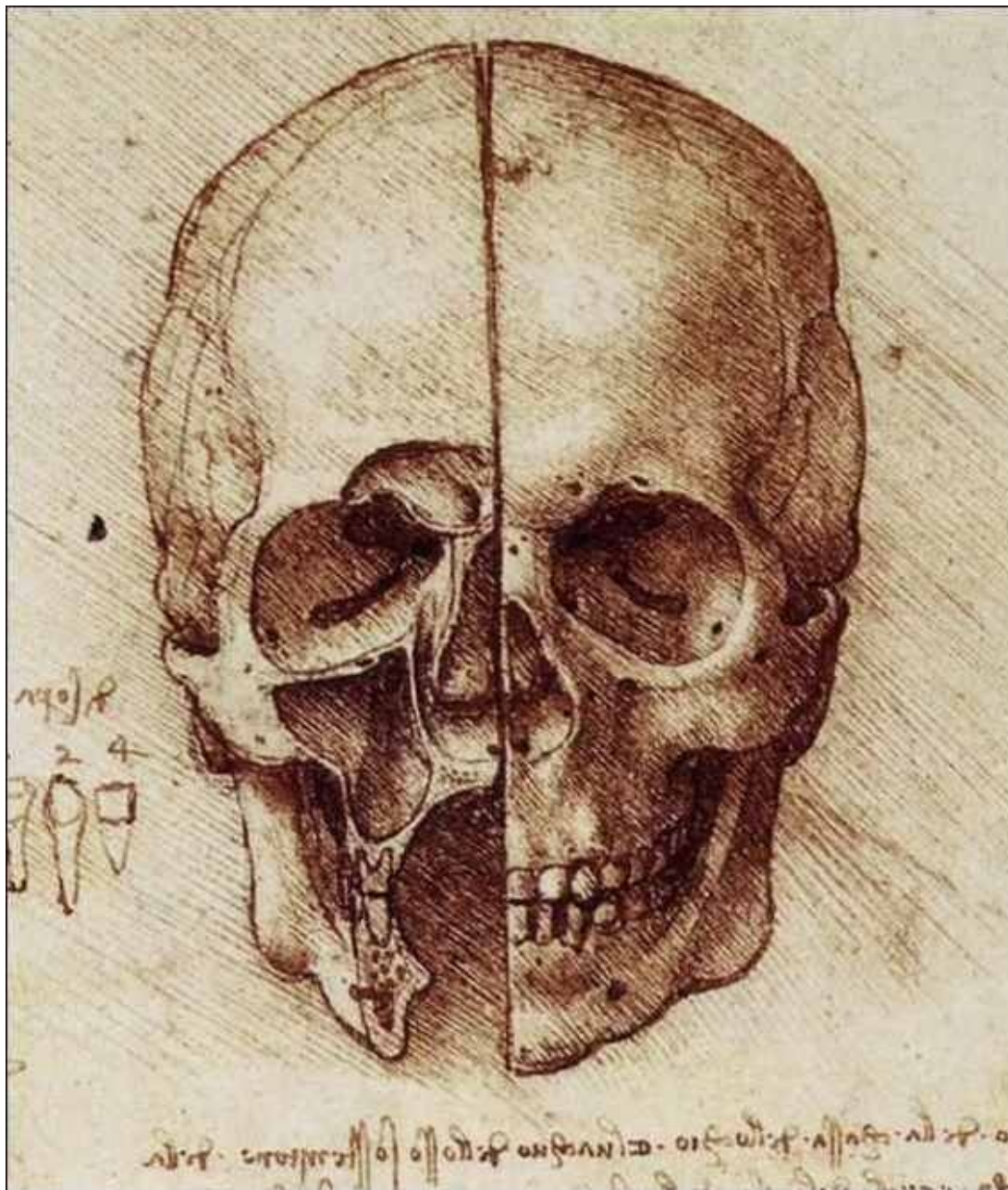
Study for the Sforza Monument, c. 1488-9



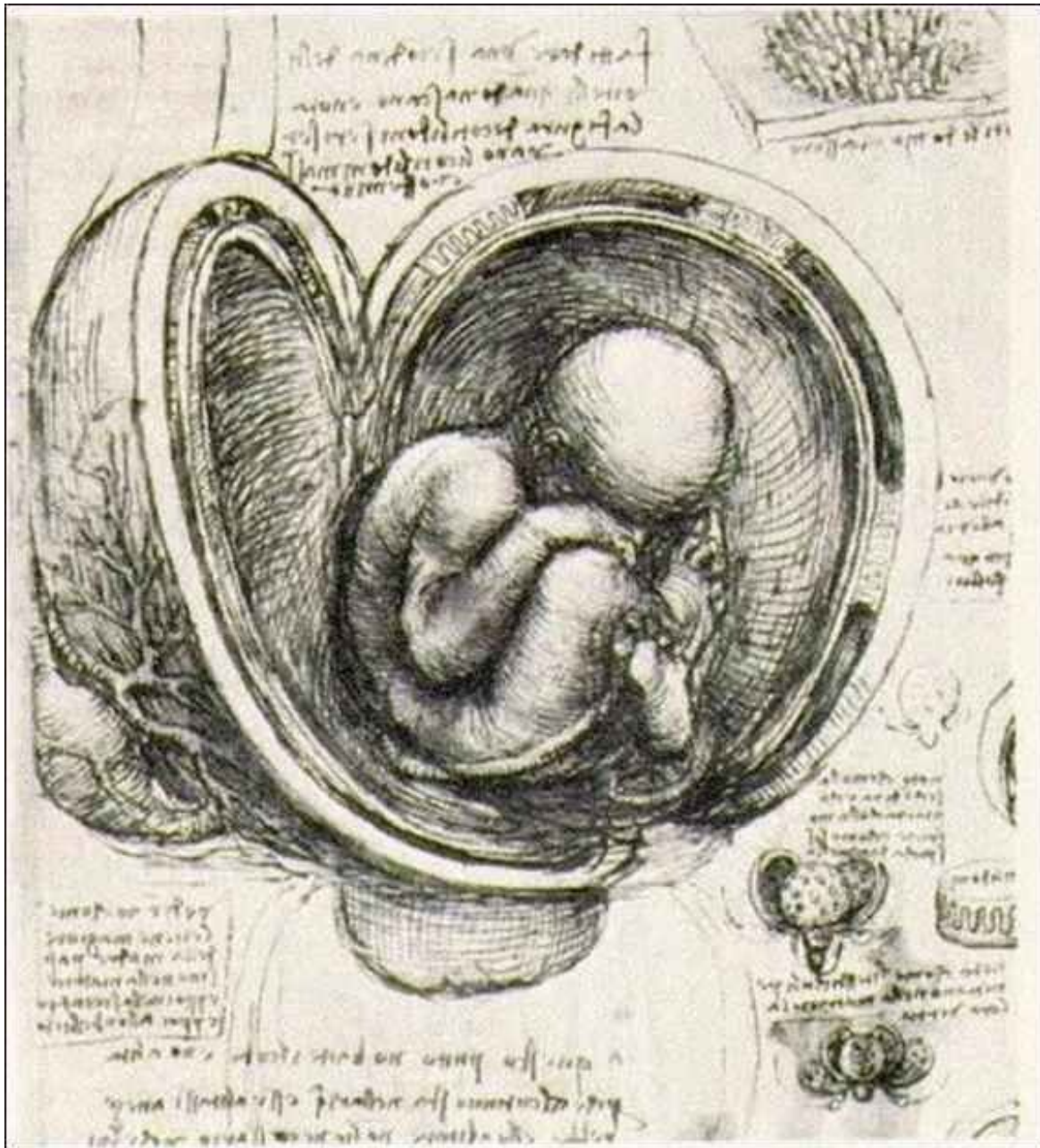
View of a Skull, c. 1489



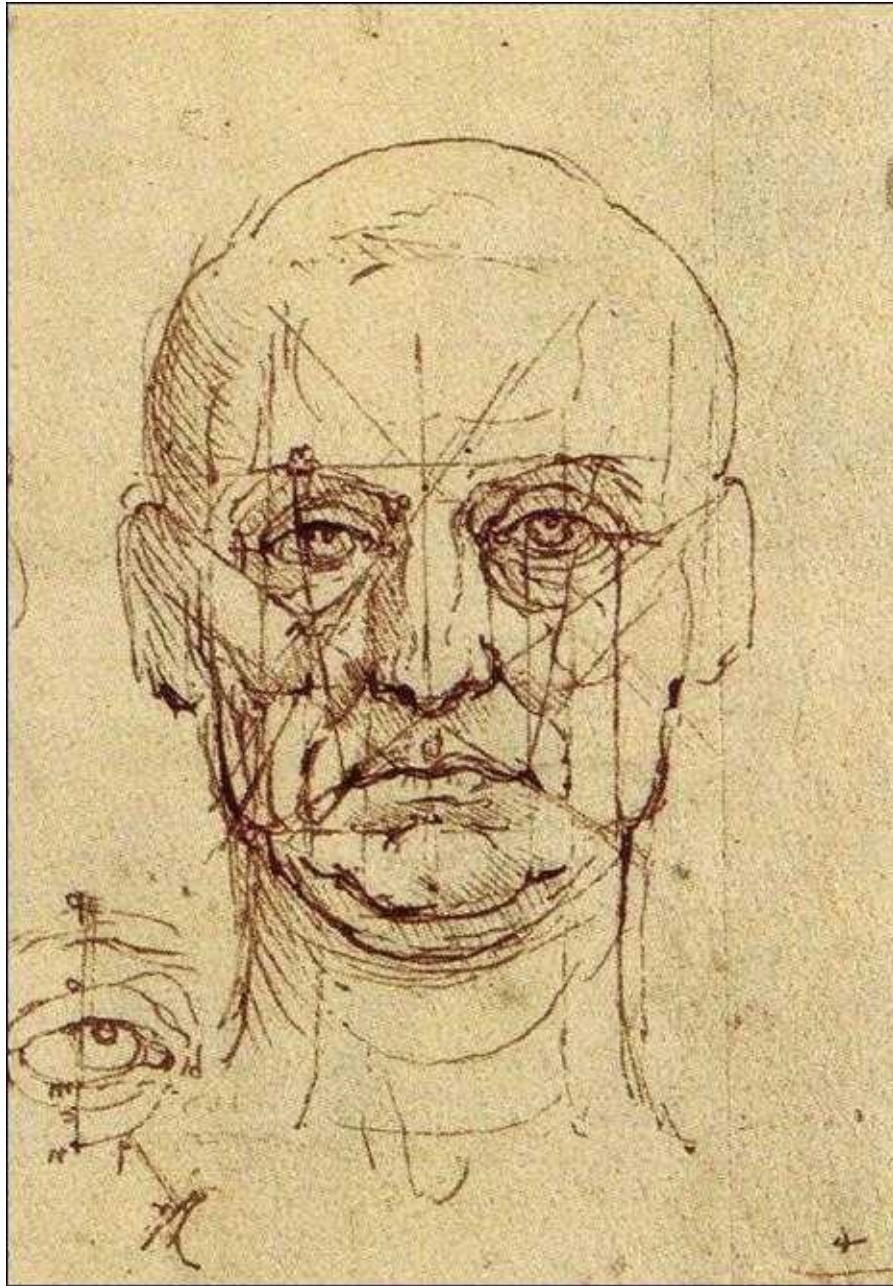
View of a Skull, c. 1489



View of a Skull, c. 1489



Study of a Womb, c. 1489



Proportions of the Face and Eye, c. 1489



Five Characters in a Comic Scene, c. 1490



Ill-matched Couple, c. 1490



Study of a Woman, c. 1490



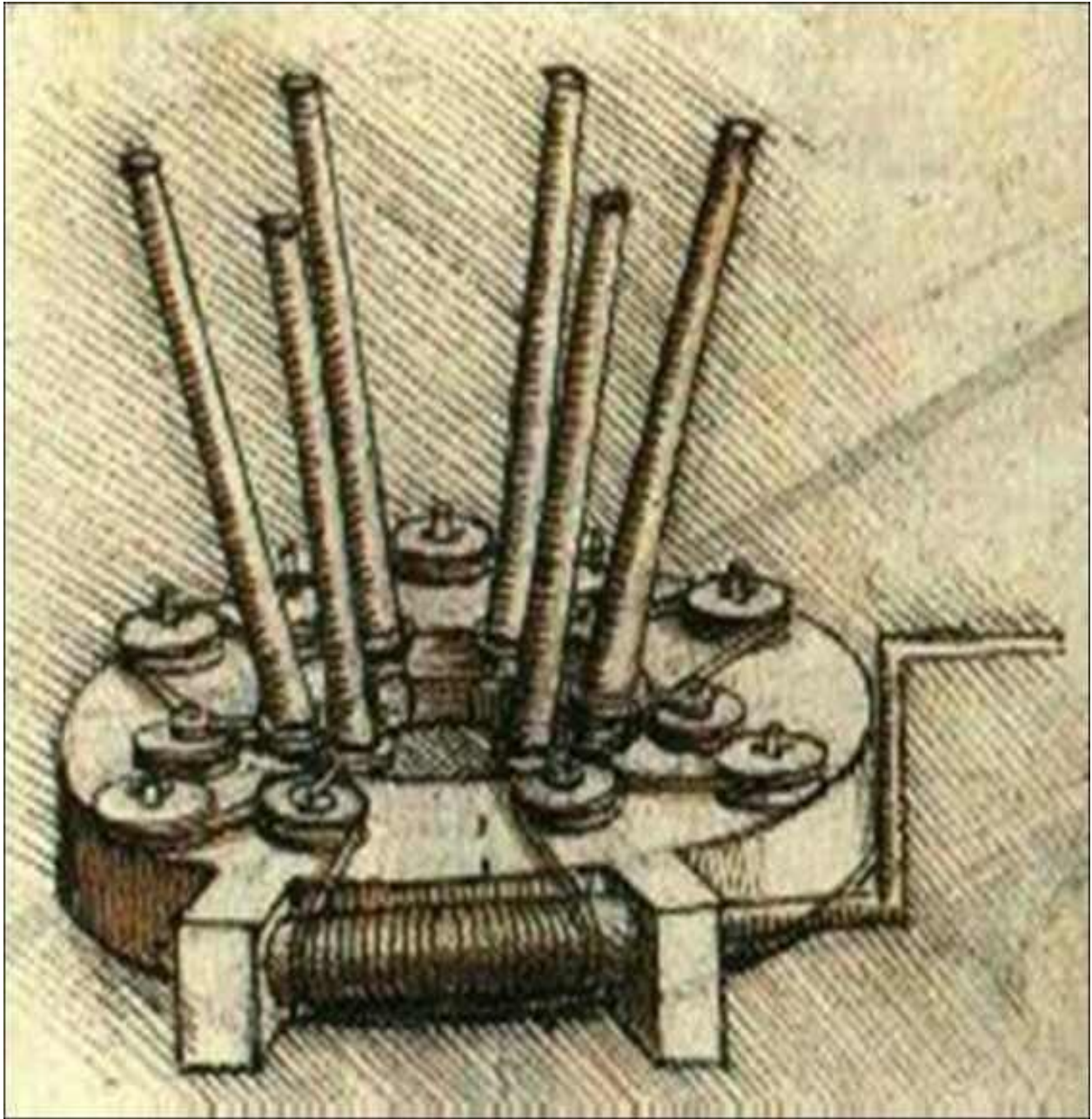
Christ Figure, c. 1490-5



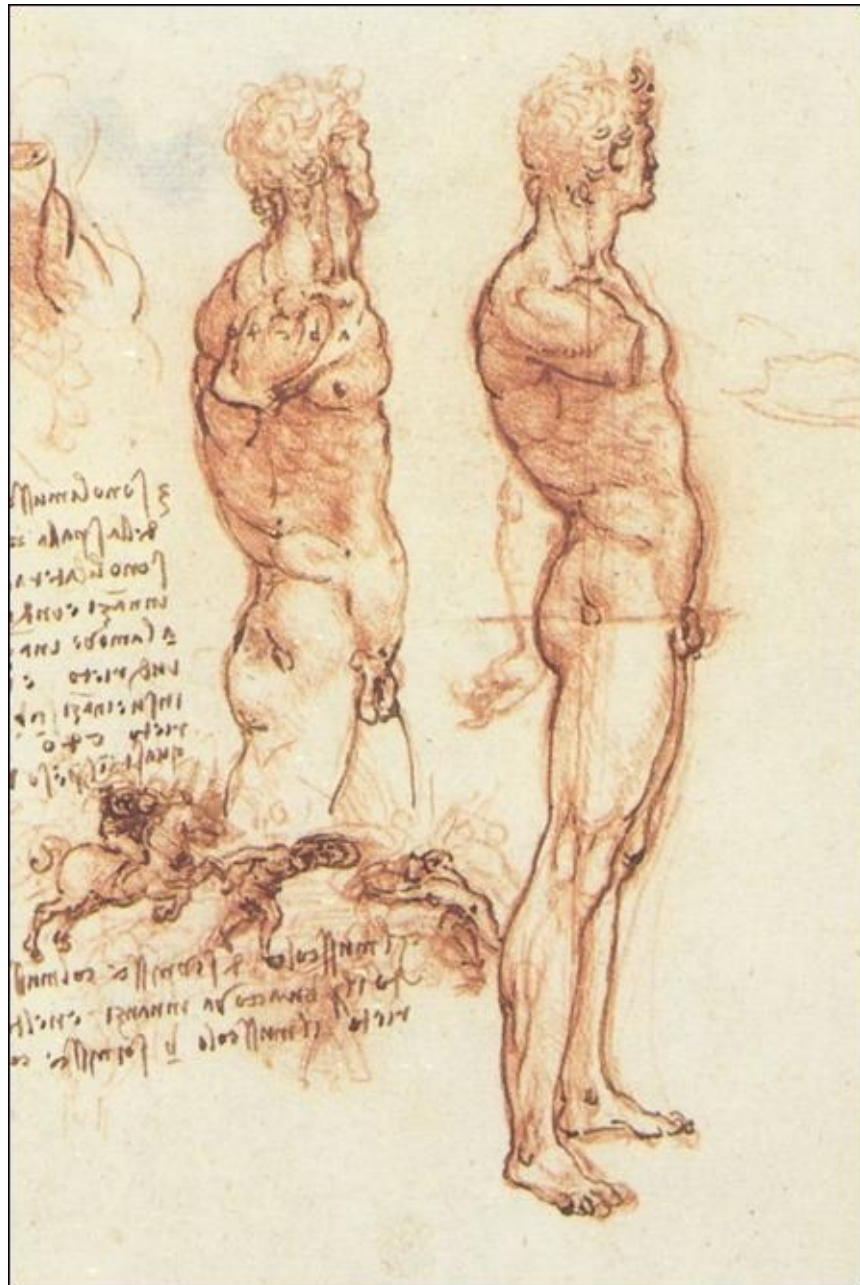
Coition of a Hemisected Man and Woman, c. 1492



Study for the Last Supper, c. 1495



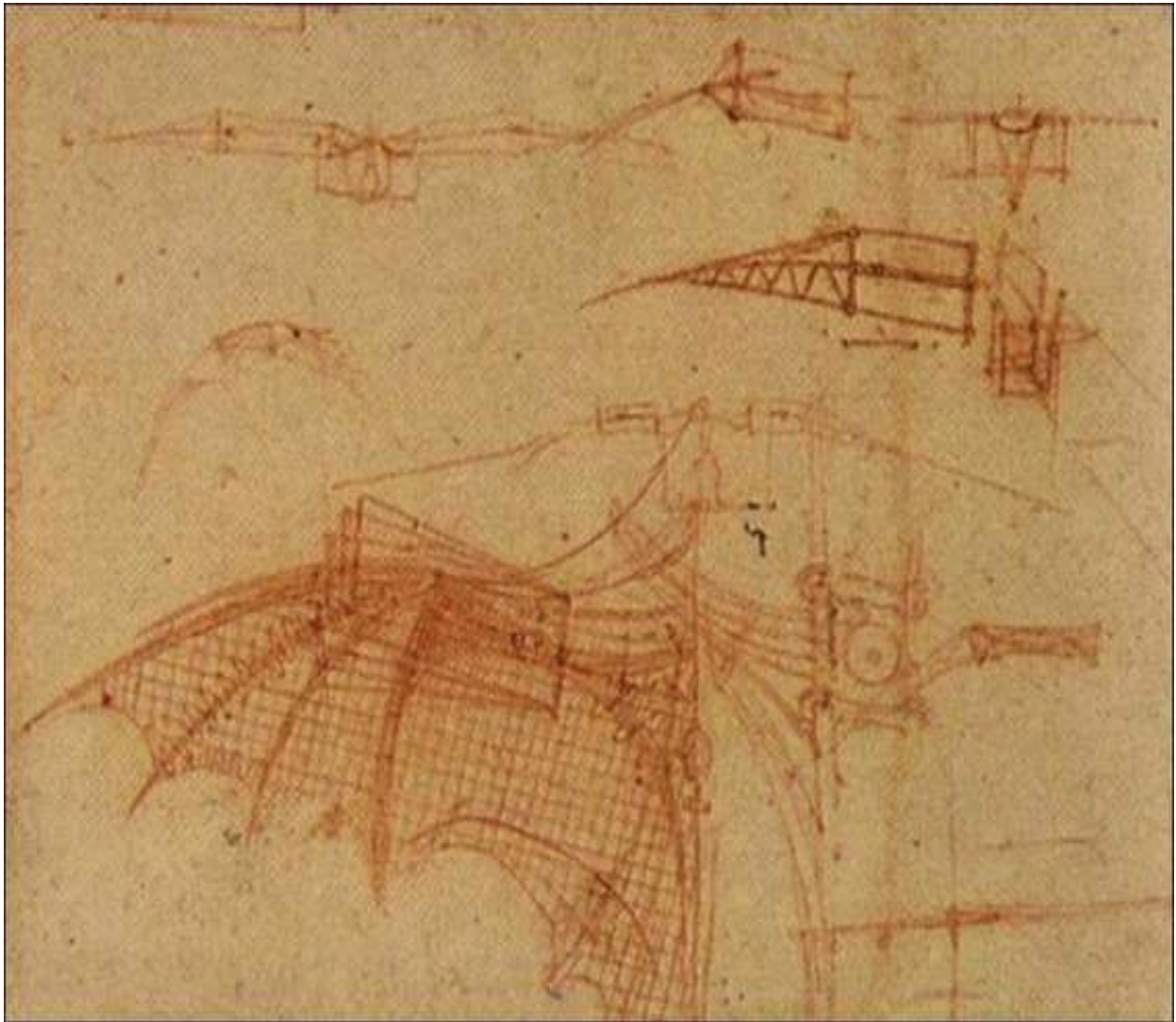
Stretching Device for a Barrel Spring, c. 1498



Anatomy of a Male Nude, c 1504-6



A Grotesque Head, c. 1504-7



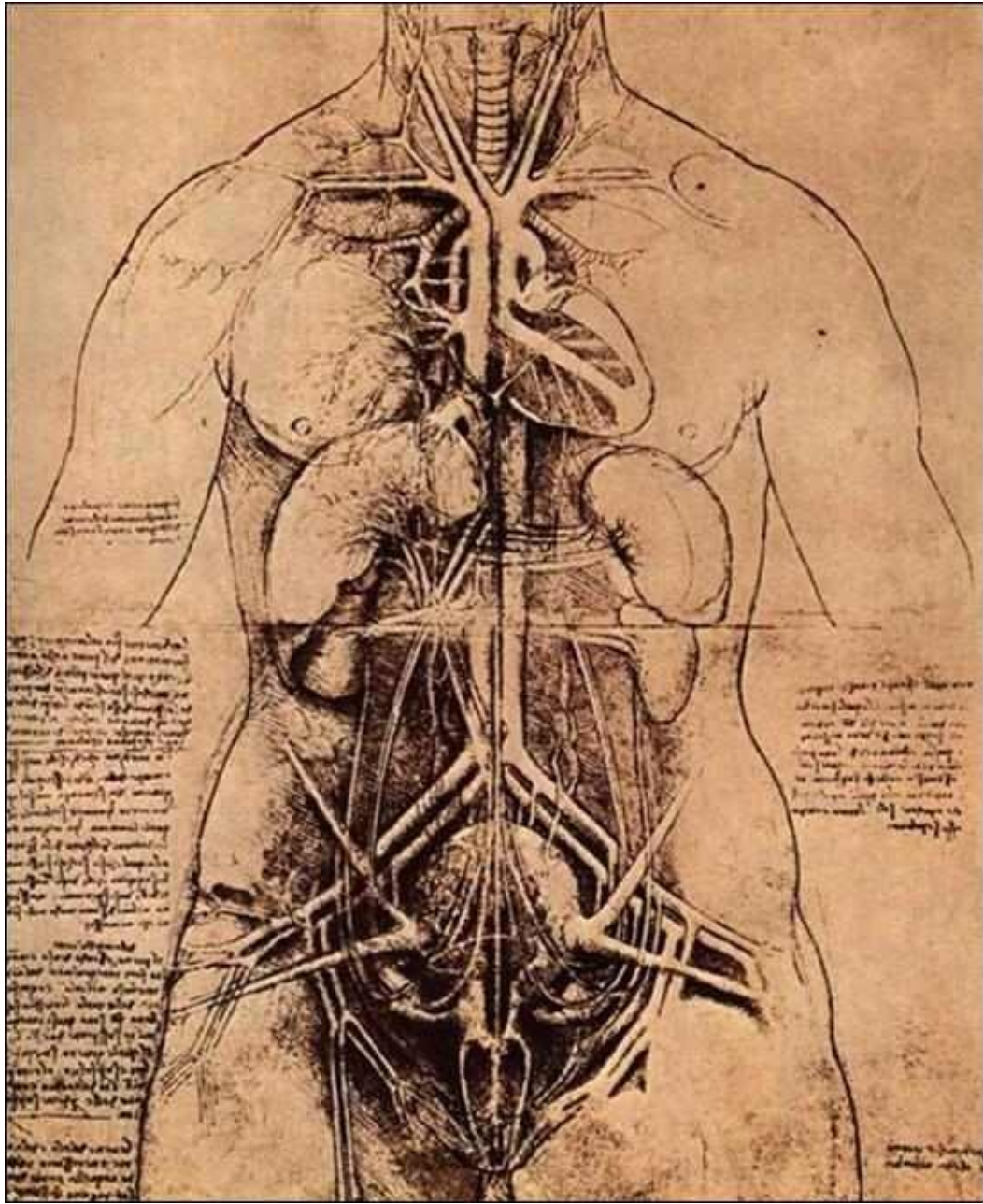
Design for a Flying Machine, c. 1505



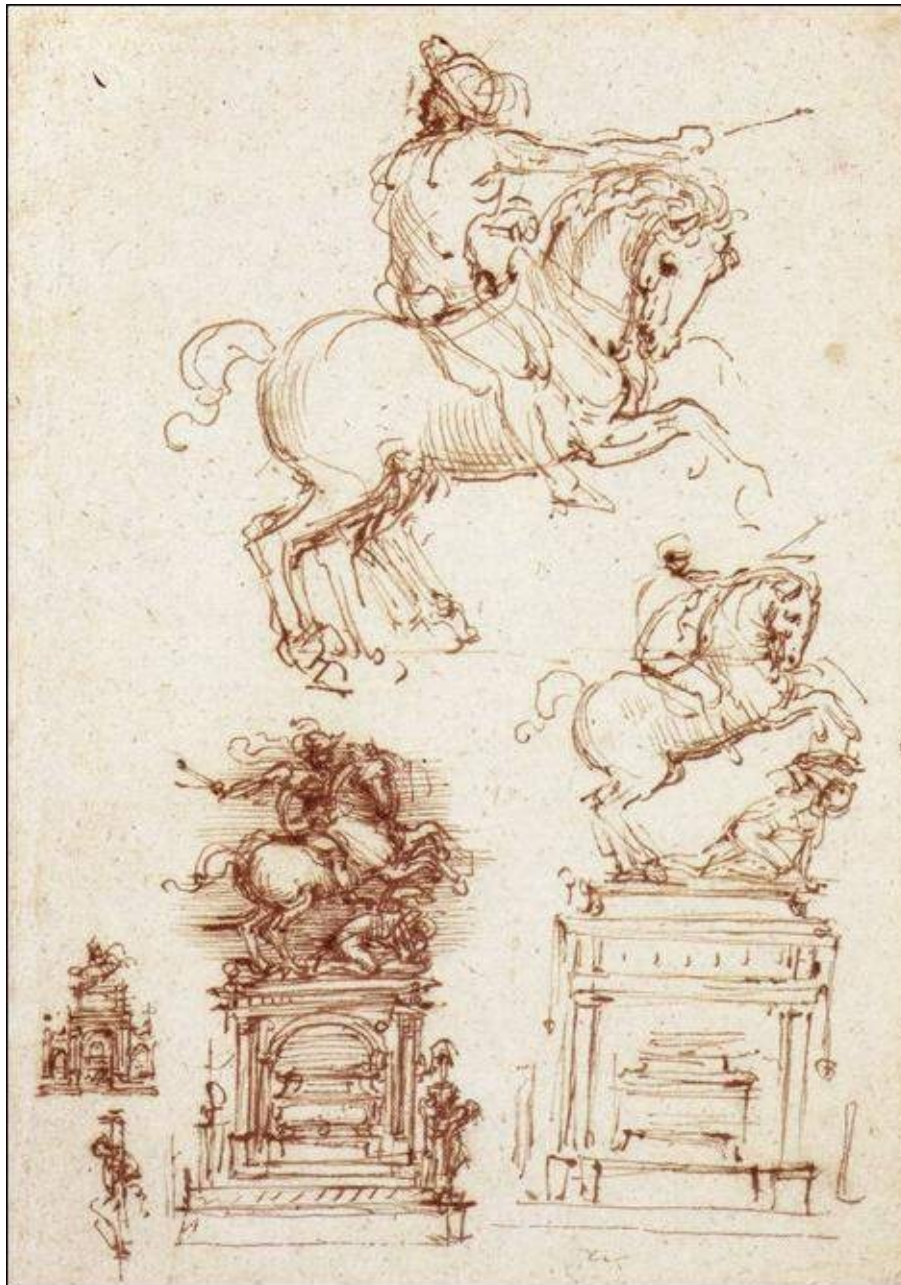
Study for the Head of Leda, c. 1505-7



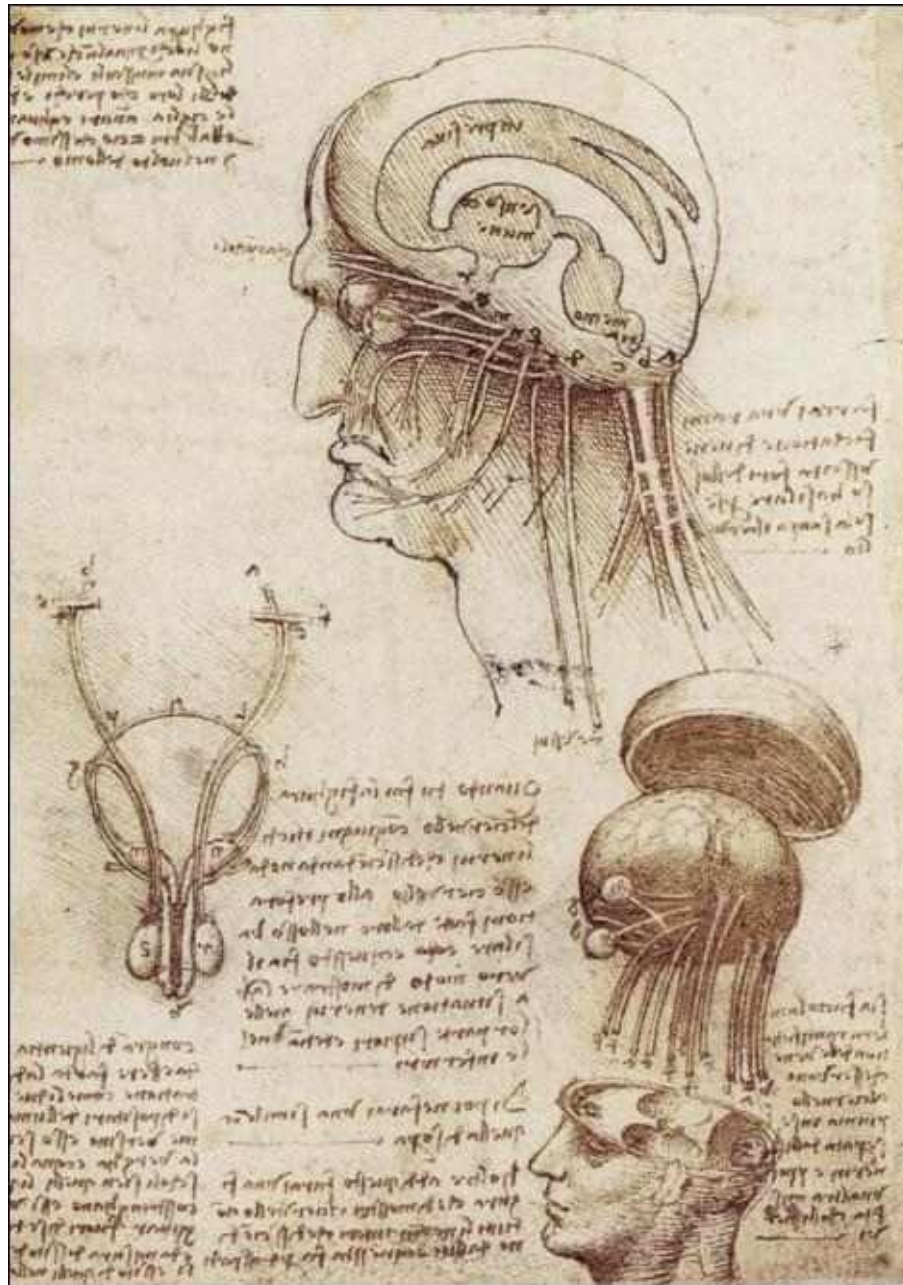
Study for the Kneeling Leda, c. 1505-7



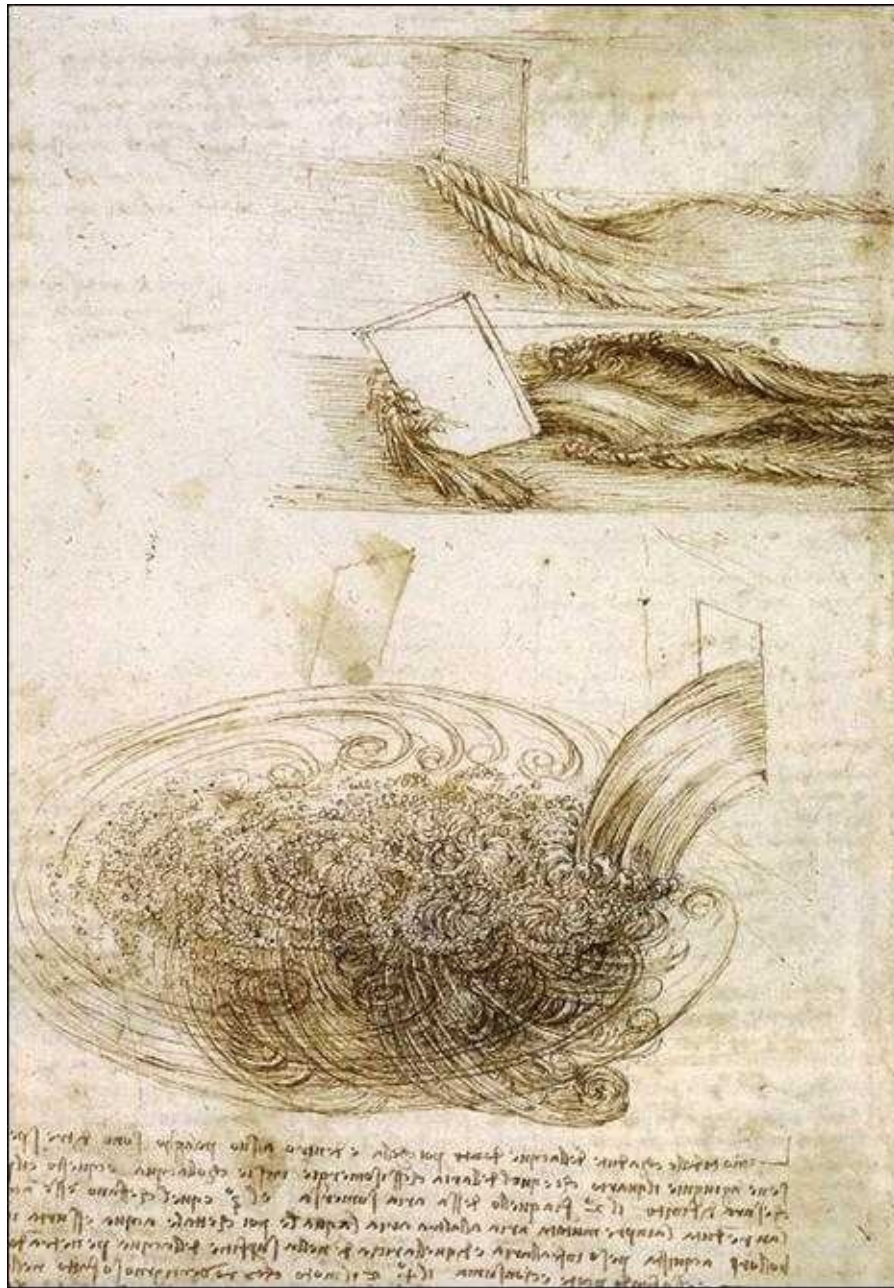
The Principal Organs and Vascular and Urino-Genital Systems of a Woman, c. 1507



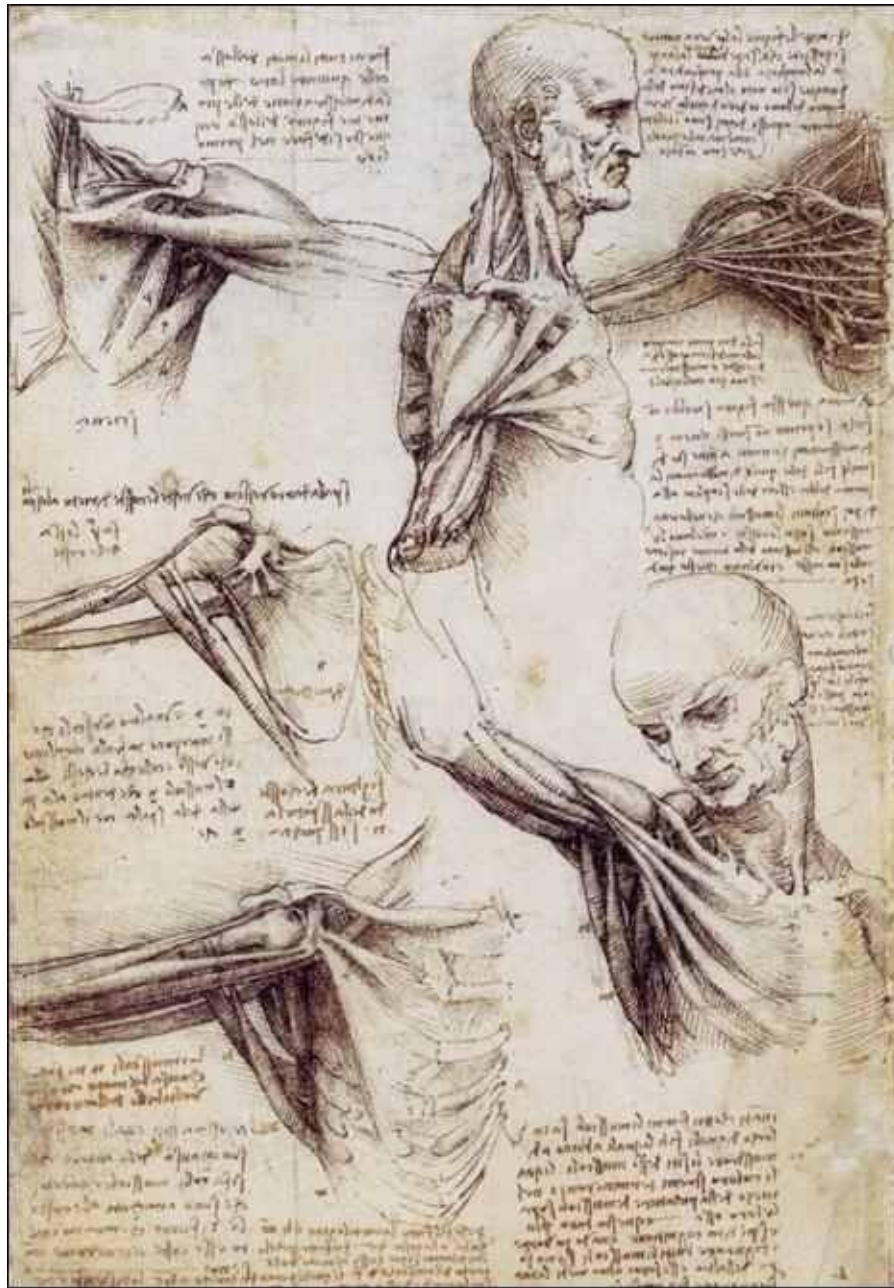
Study for the Trivulzio Monument, c. 1508



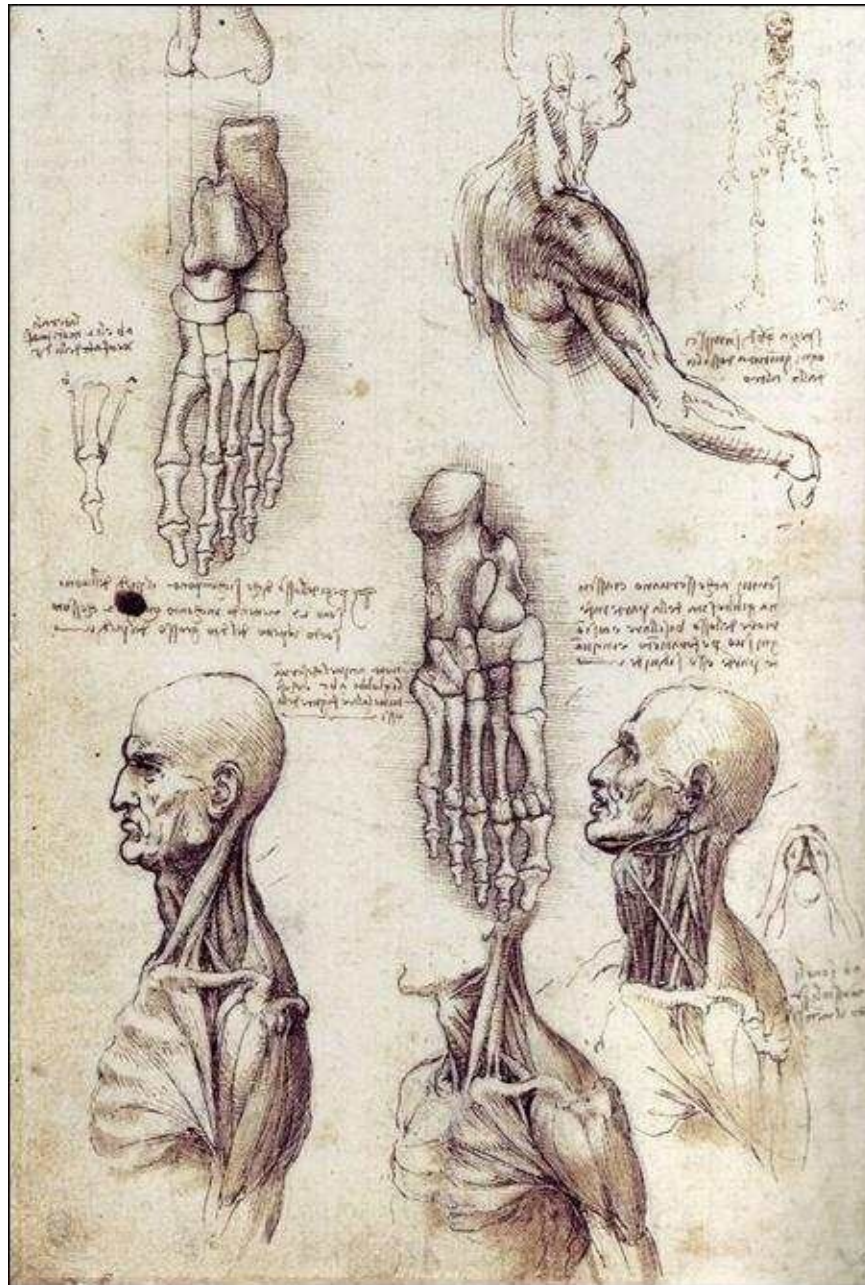
Study of Brain Physiology, c. 1508



Studies of Water passing Obstacles and falling, c. 1508-9



Studies of the Shoulder and Neck, c. 1509-1510



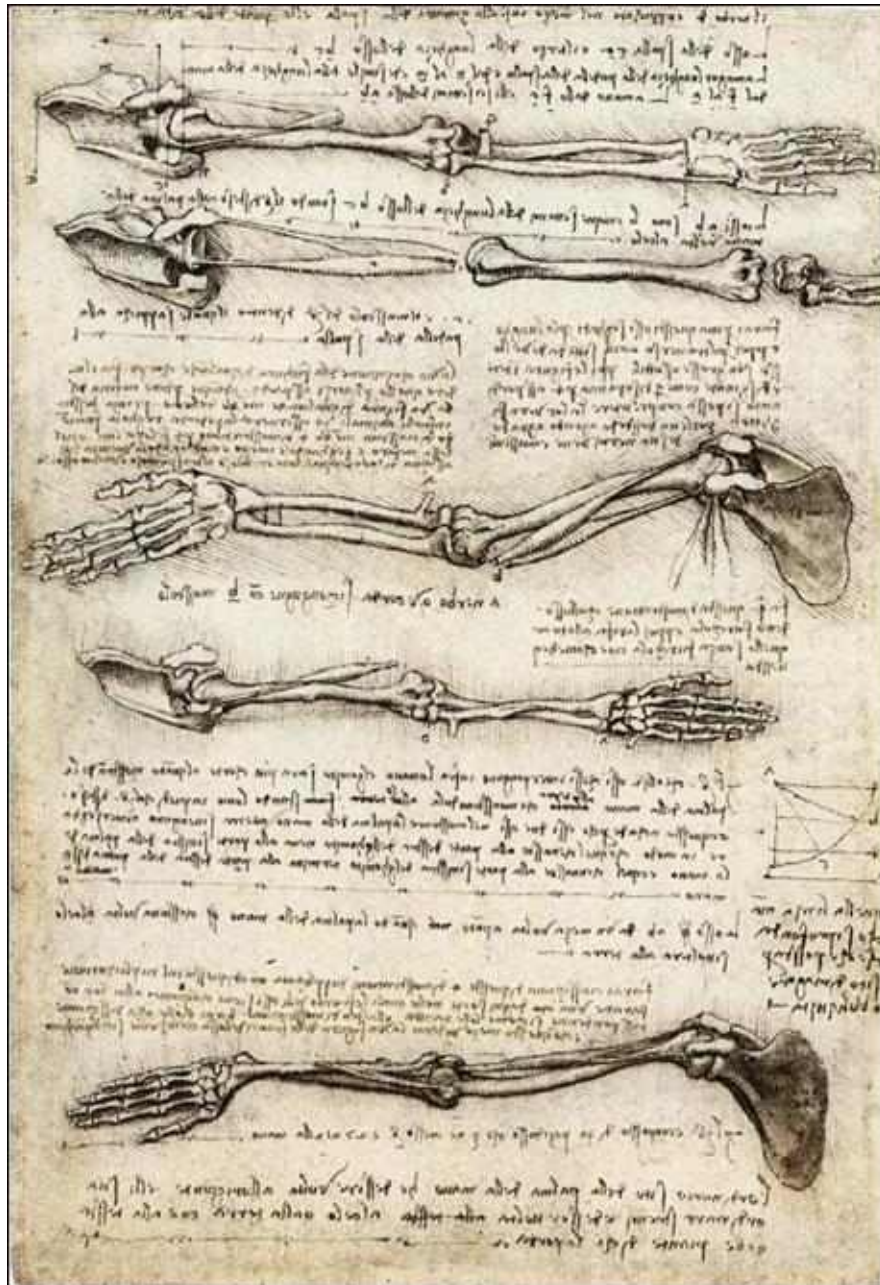
Studies of the Shoulder and Neck, c. 1509-1510



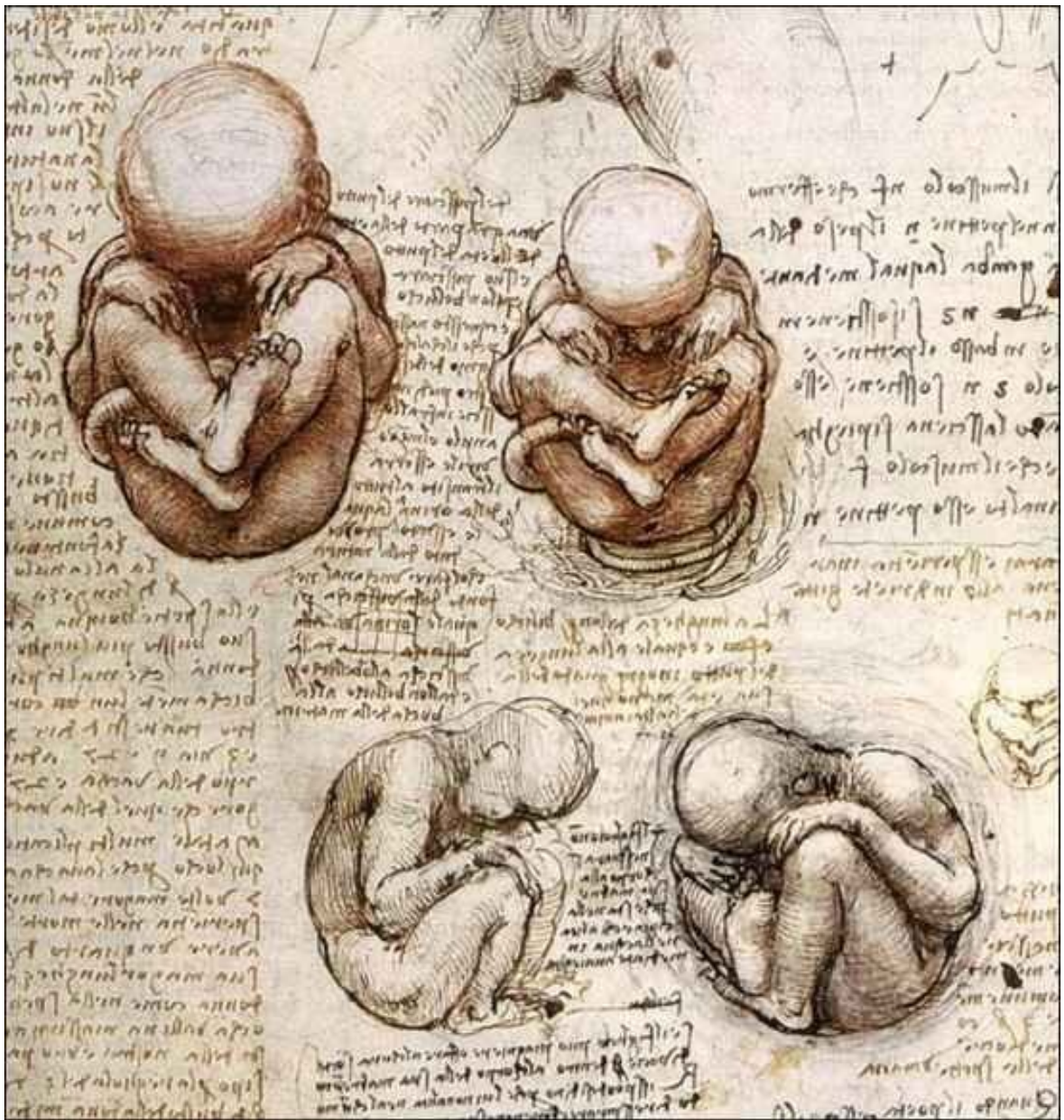
Studies of the Shoulder and Neck, c. 1509-1510



Sedge, c. 1510



Studies of the Arm showing the Movements made by the Biceps, c. 1510



Views of a Fetus in the Womb, c. 1510-12



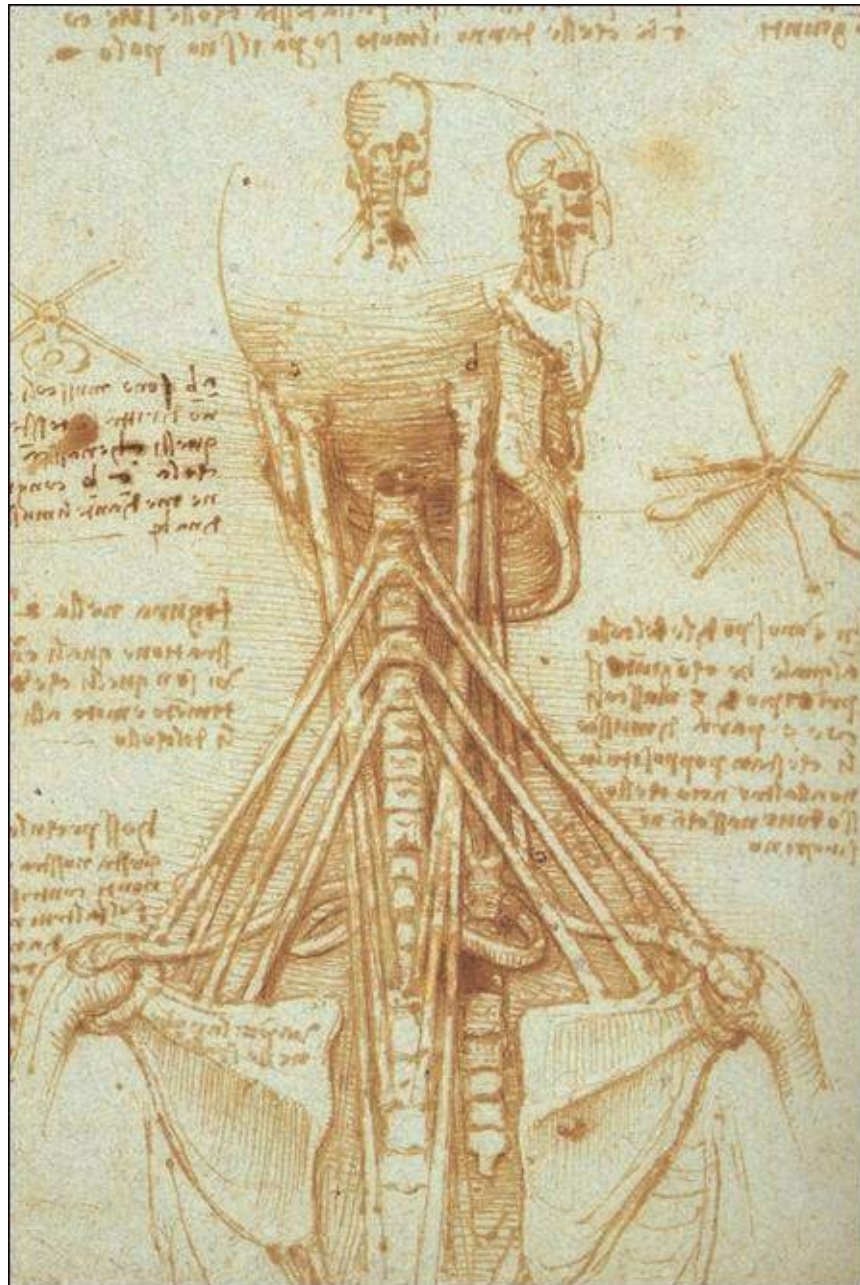
Head of Saint Anne, c. 1510-5



Study of Cats and Other Animals c. 1513



Old Man with Water Studies, c. 1513



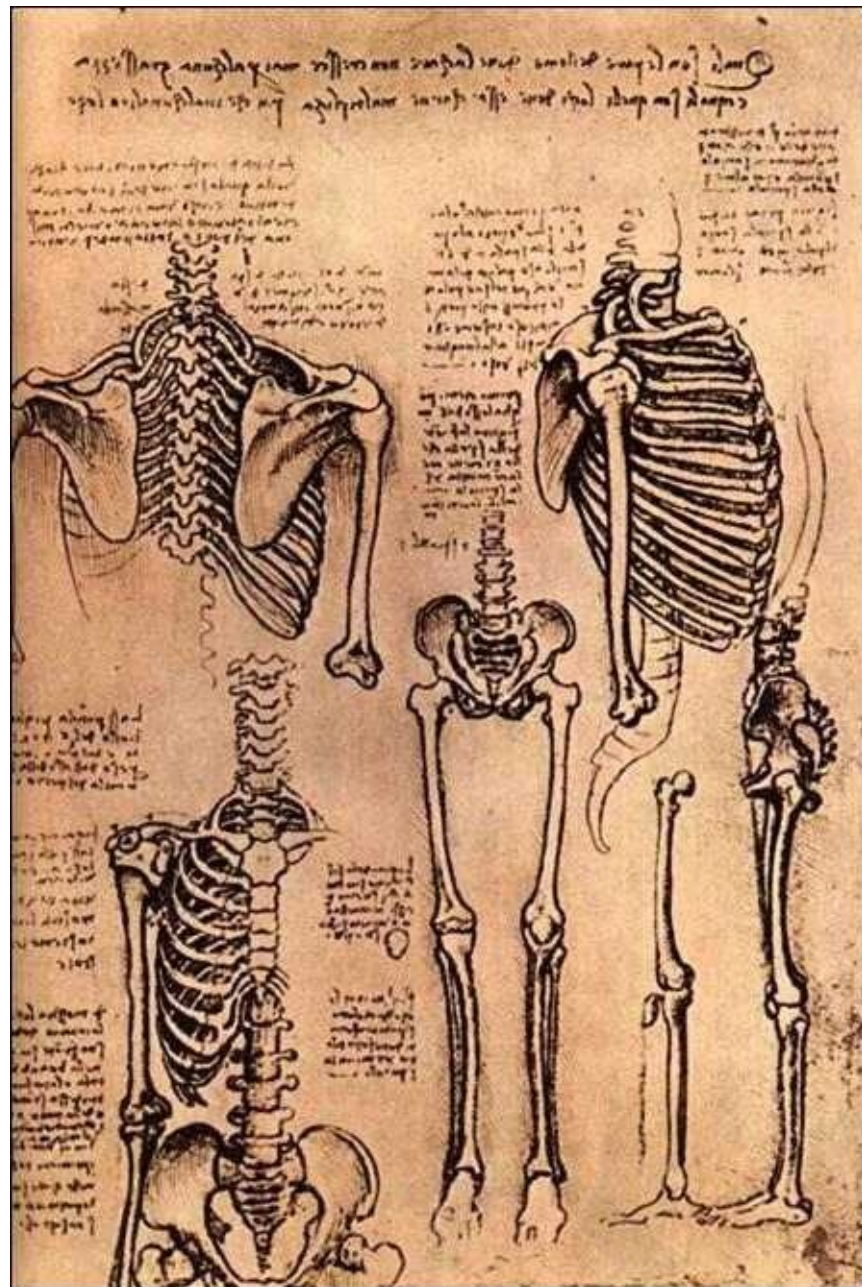
Anatomy of the Neck, c. 1515



Detail from a Study of a Dragon Costume, c. 1517-8



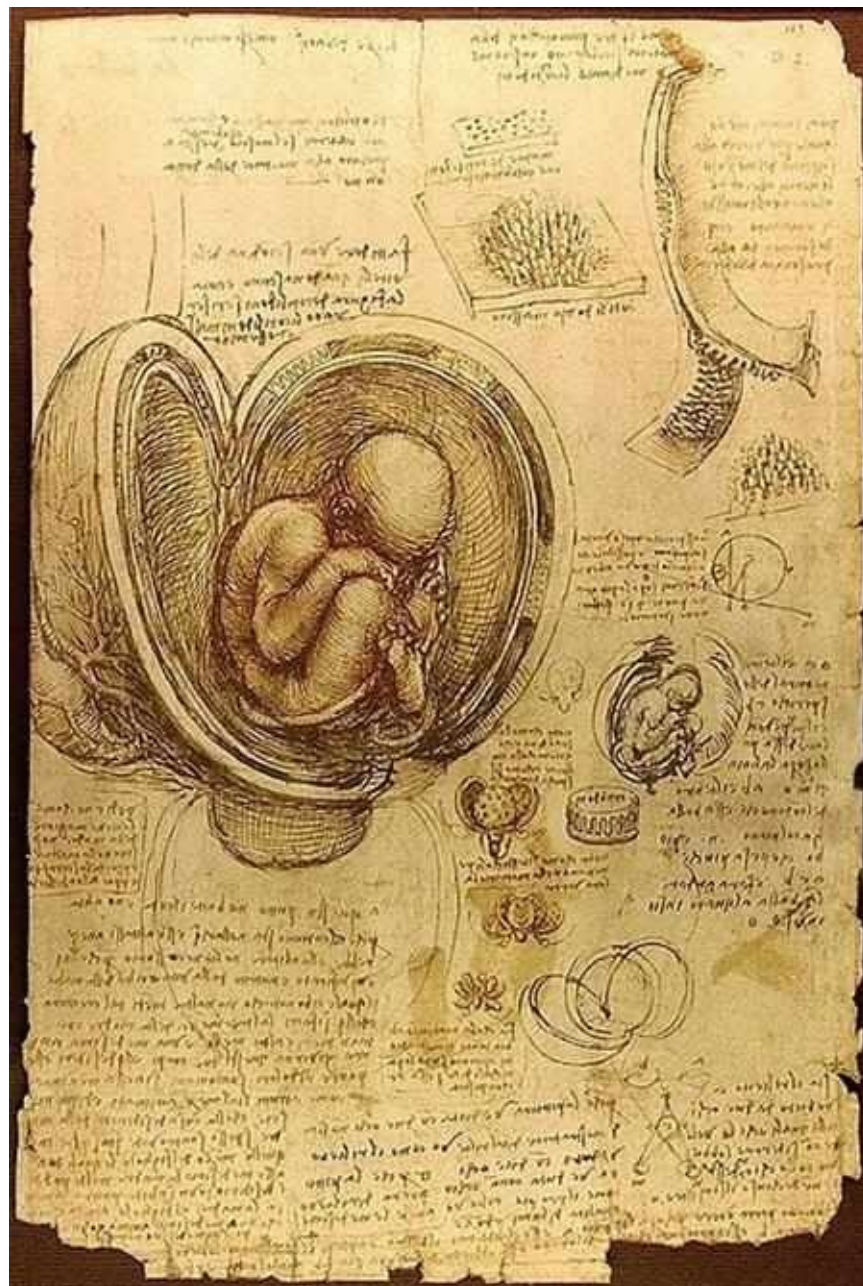
Masquerader in the guise of a Prisoner, c. 1517-8



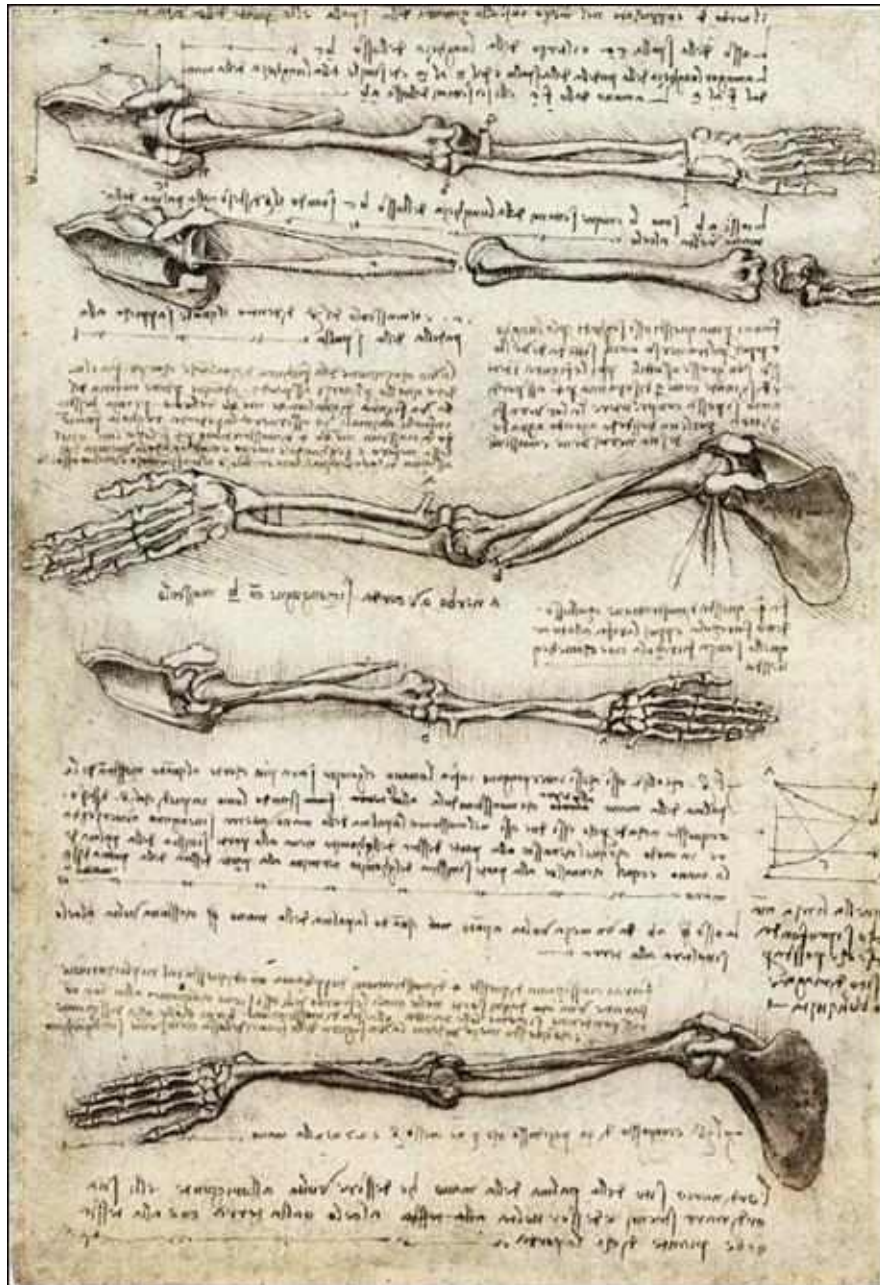
Study of Skeletons



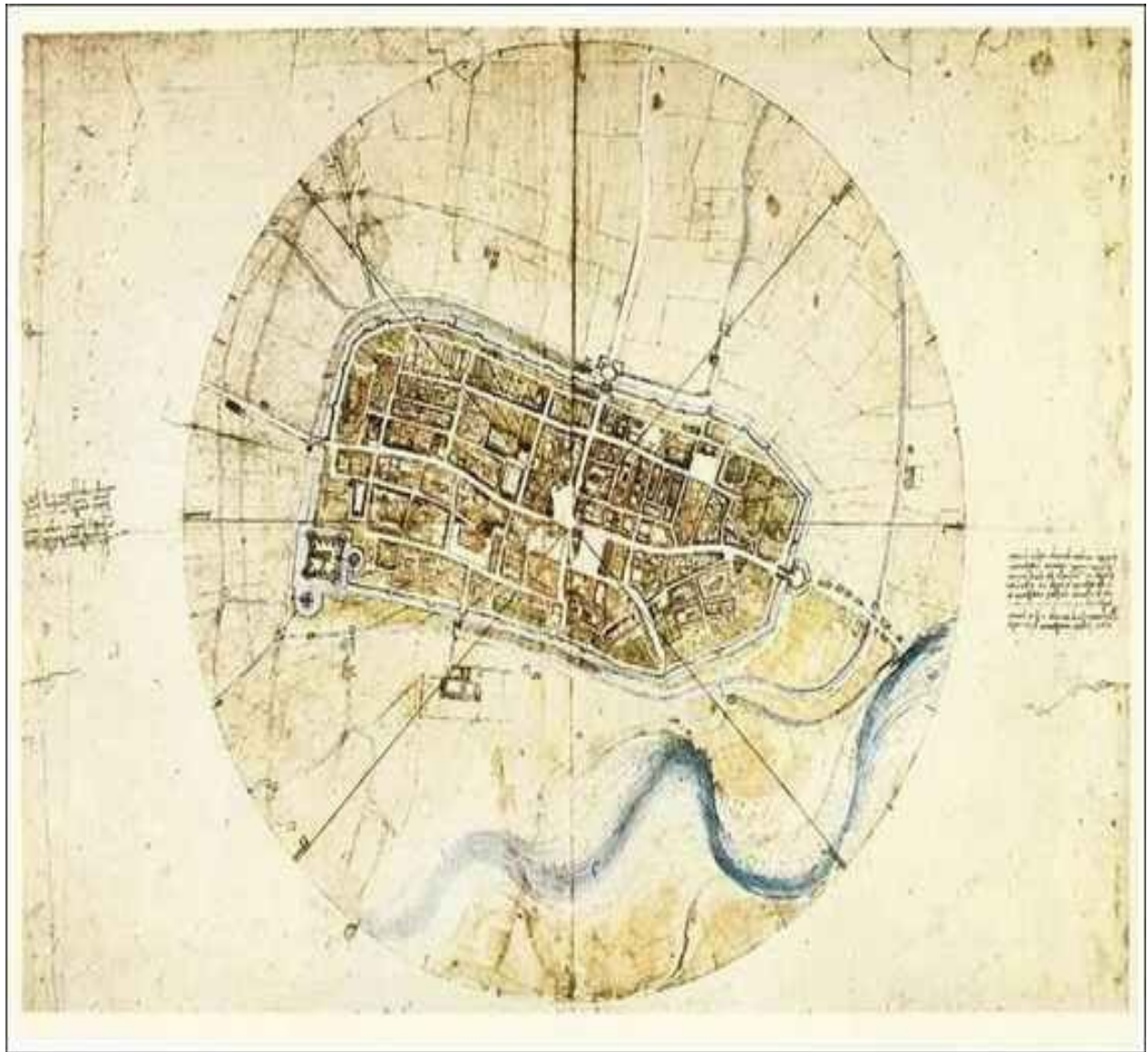
Study of a Figure for the Battle of Anghiari



Study of a foetus in the womb, c. 1510



Anatomical study of the arm, (c. 1510)



Leonardo da Vinci's very accurate map of Imola, created for Cesare Borgia

The Notebooks



'Francis I of France receiving the last breath of Leonardo da Vinci', by the French Master Ingres, 1818

THE NOTEBOOKS OF LEONARDO DA VINCI



Translated by Jean Paul Richter

Leonardo's notes and drawings demonstrate an enormous range of interests and preoccupations, some as mundane as lists of groceries and people who owed him money and some as intriguing as designs for wings and shoes for walking on water. There are compositions for paintings, studies of details and drapery, studies of faces and emotions, of animals, babies, dissections, plant studies, rock formations, whirlpools, war machines, helicopters and architecture.

These notebooks, which were originally loose papers of different types and sizes, distributed by friends after his death, have found their way into major collections such as the Royal Library at Windsor Castle, the Louvre, the Biblioteca Nacional de España, the Victoria and Albert Museum, the Biblioteca Ambrosiana in Milan which holds the twelve-volume Codex Atlanticus, and British Library in London.

The Codex Leicester, named after Thomas Coke, later created Earl of Leicester, who purchased it in 1719, is one of the most famous notebooks. The manuscript holds the record for the current sale price of any book, when it was sold to Bill Gates at Christie's auction house on 11 November 1994 in New York for \$30,802,500. The Codex provides an invaluable insight into the inquisitive mind of the artist and scientist, serving as an exceptional illustration of the link between art and science and the imagination of the scientific process.

Leonardo's notes appear to have been intended for publication because many of the sheets have a form and order that would facilitate this. In many cases a single topic, for example, the heart or the human fetus, is covered in detail in both words and pictures on a single sheet. Exactly why they were never published in Leonardo's lifetime is unknown.



A page of the Codex Leicester

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Windsor Castle, England — home to many of Leonardo's notebook works

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PLATE I



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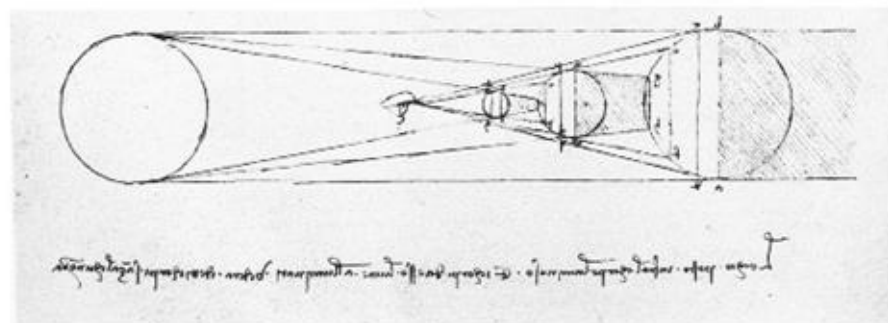
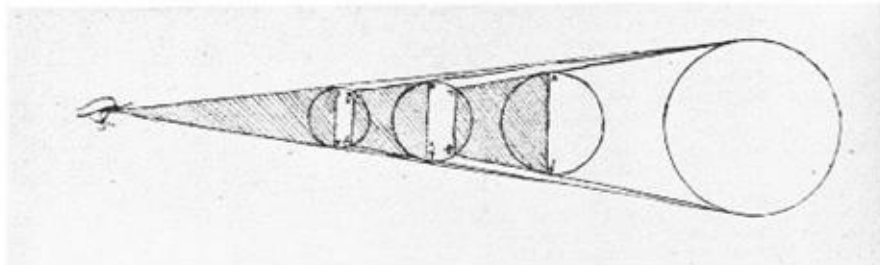
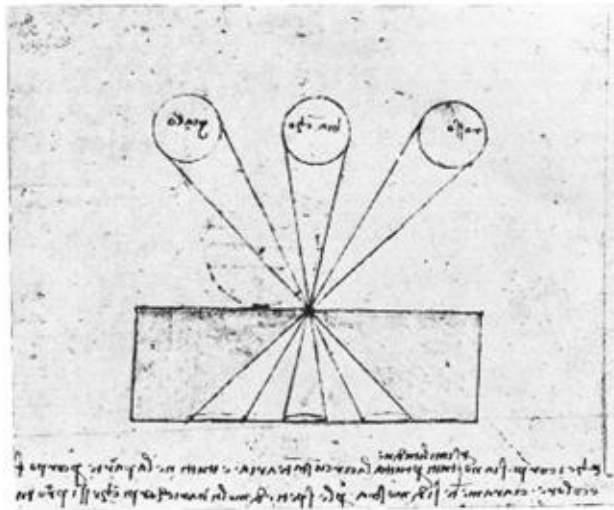


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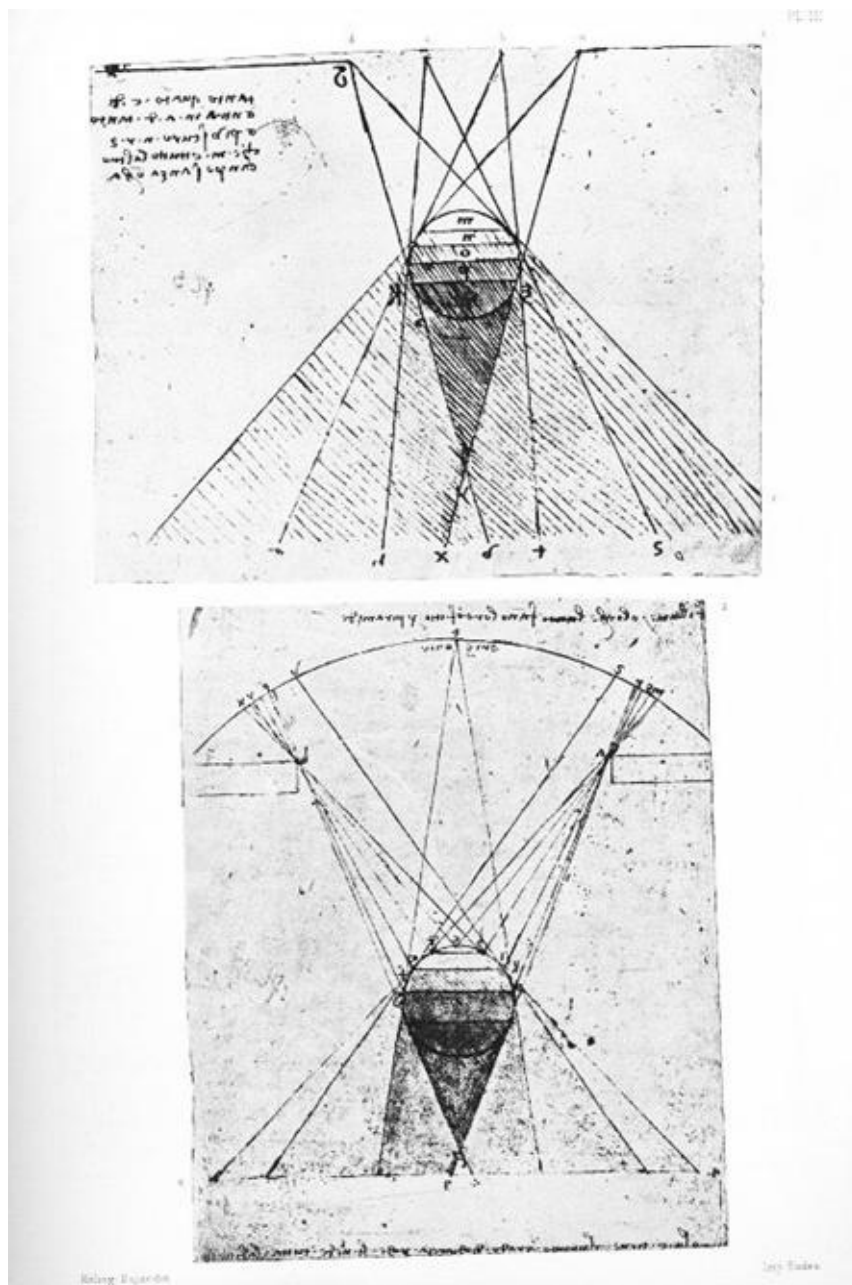


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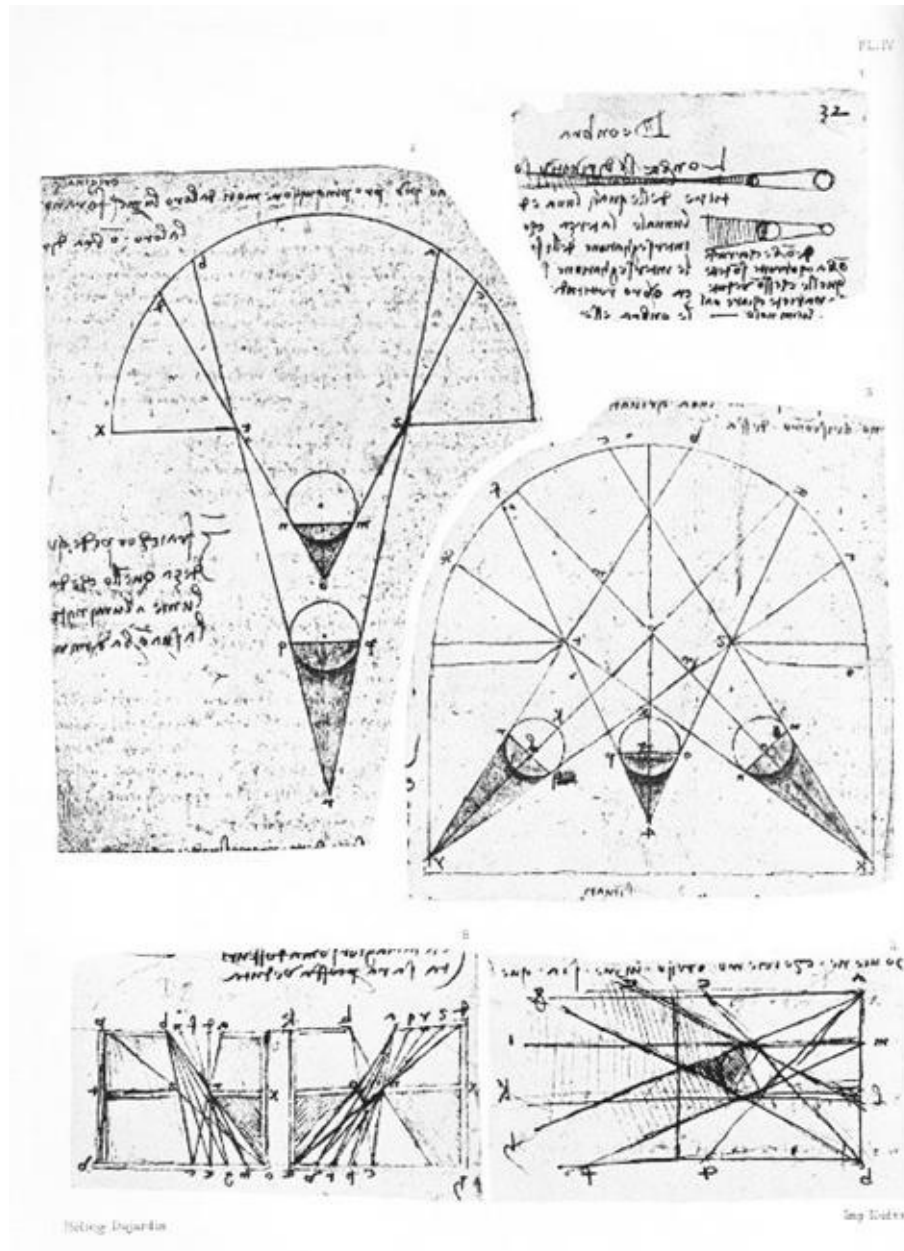


PLATE V



PLATE VI

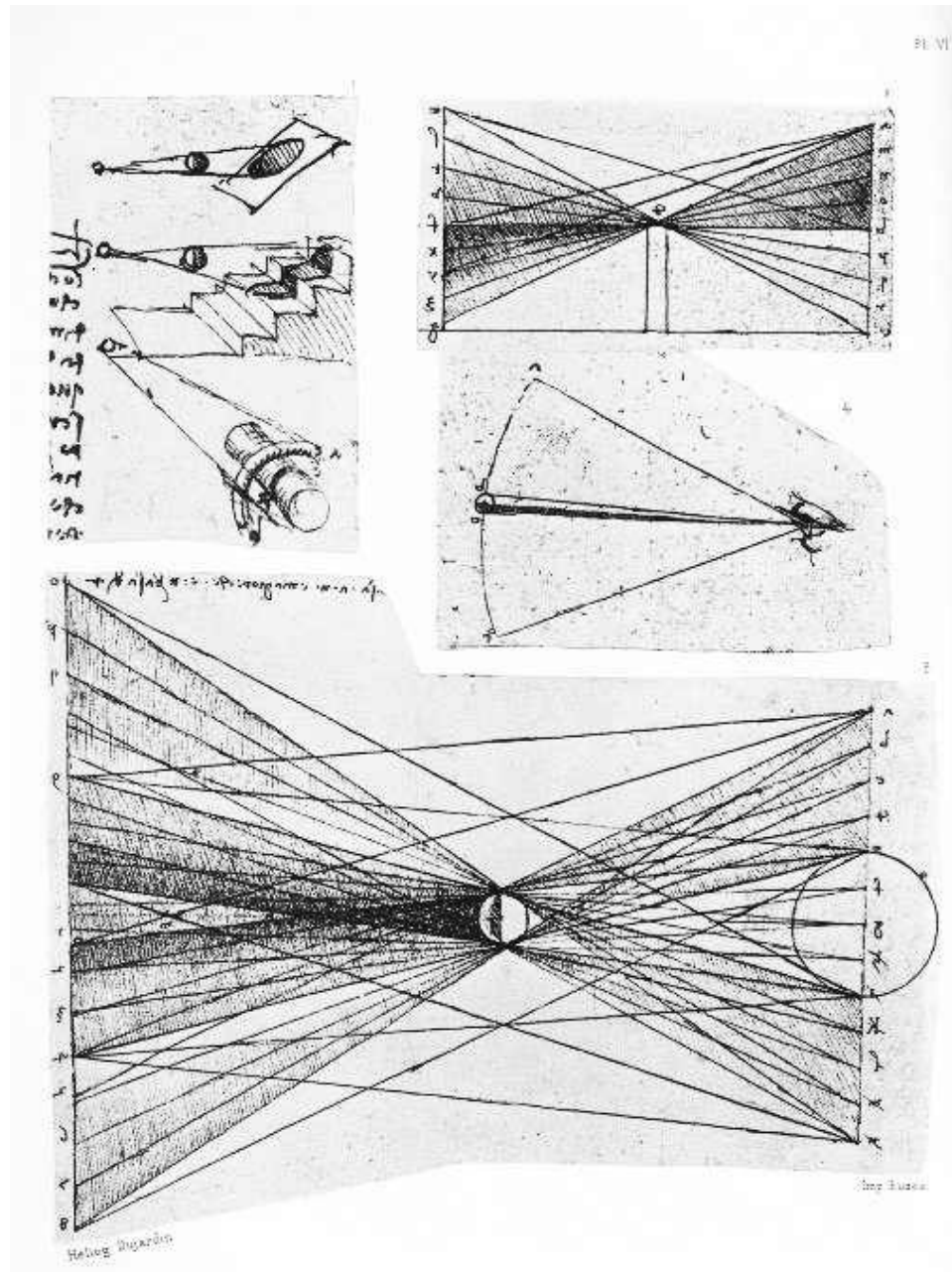
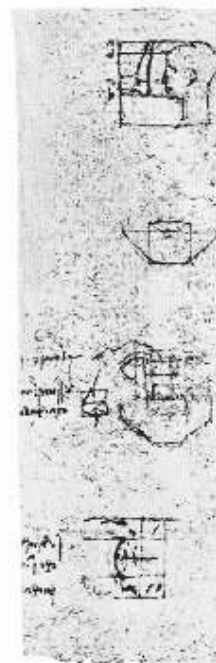
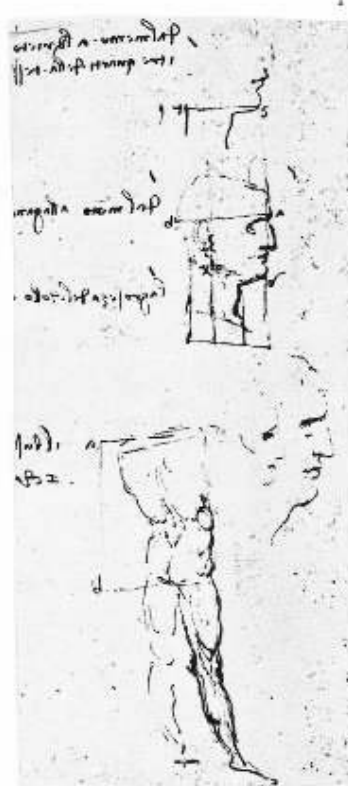


PLATE VII



Helwig Dujardin



Imy Kuden

PLATE VIII

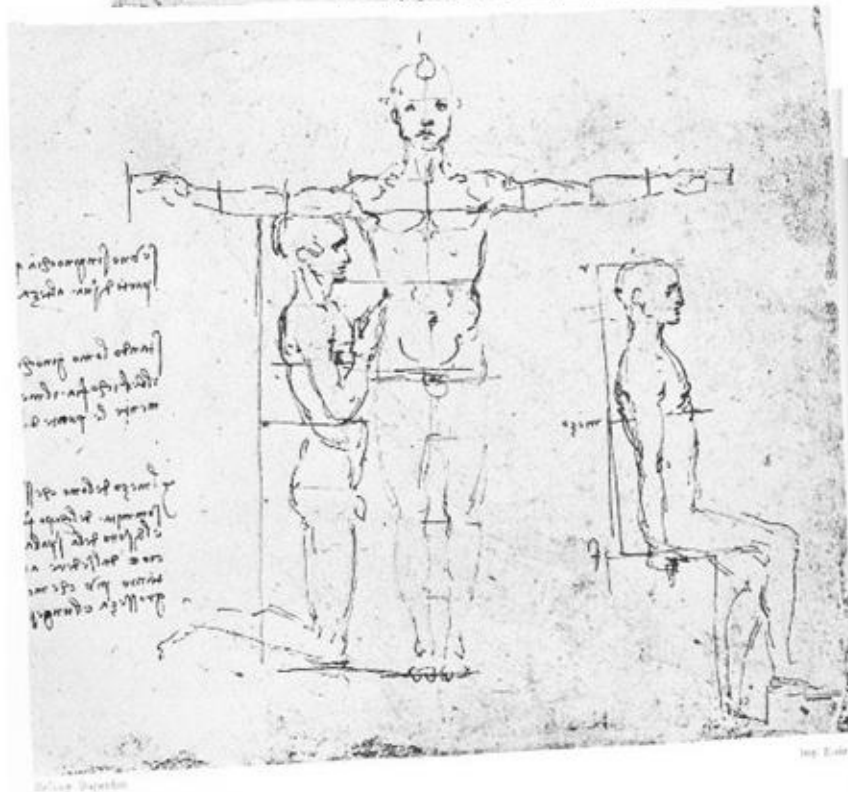
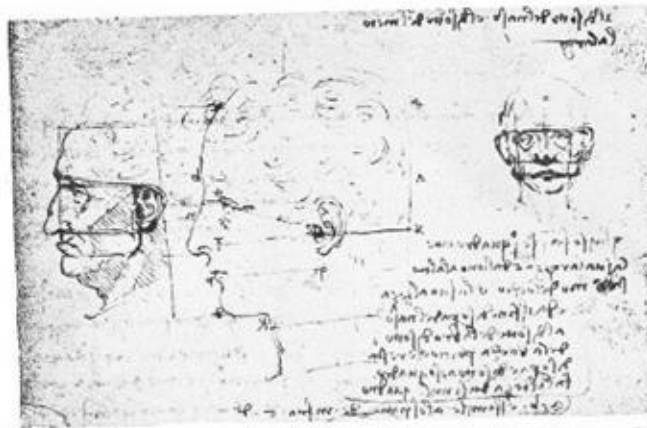


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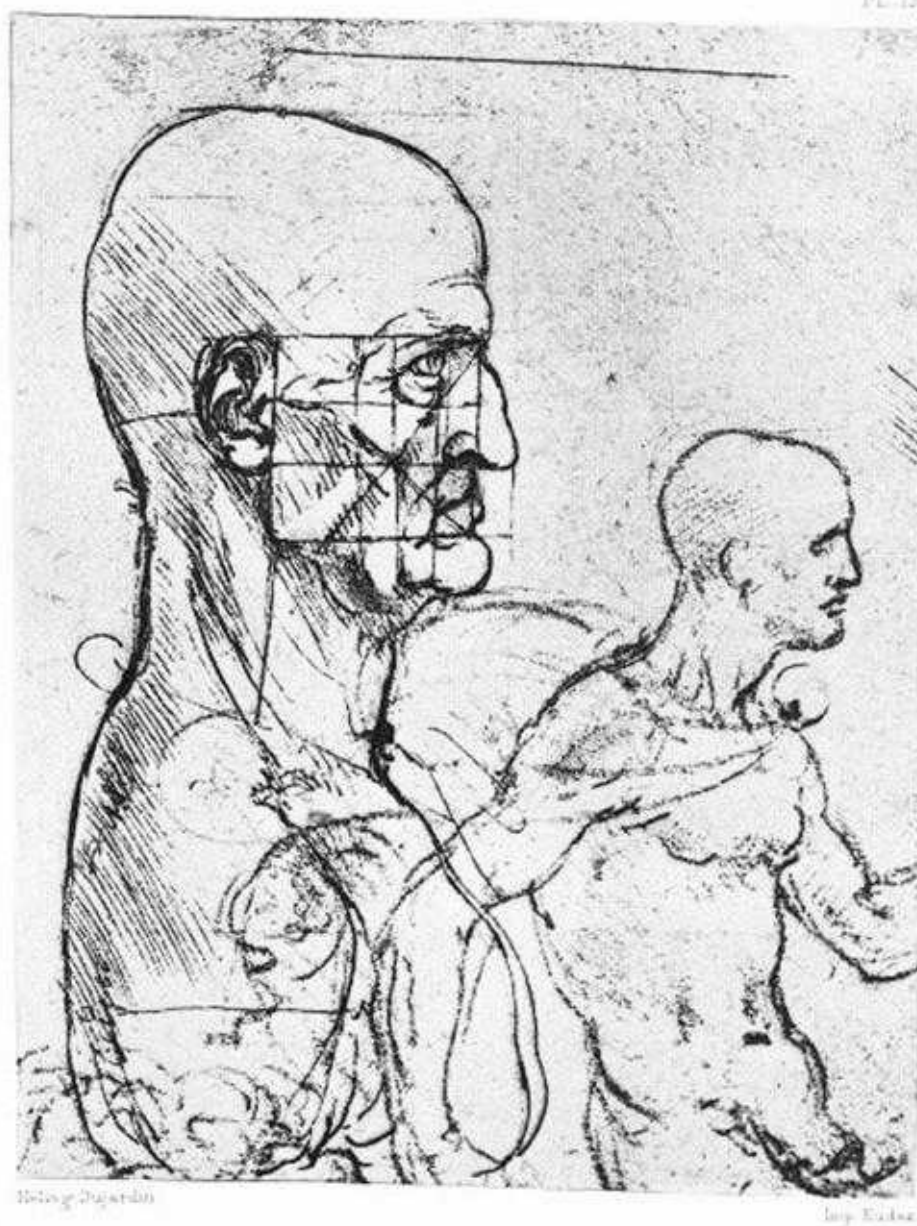


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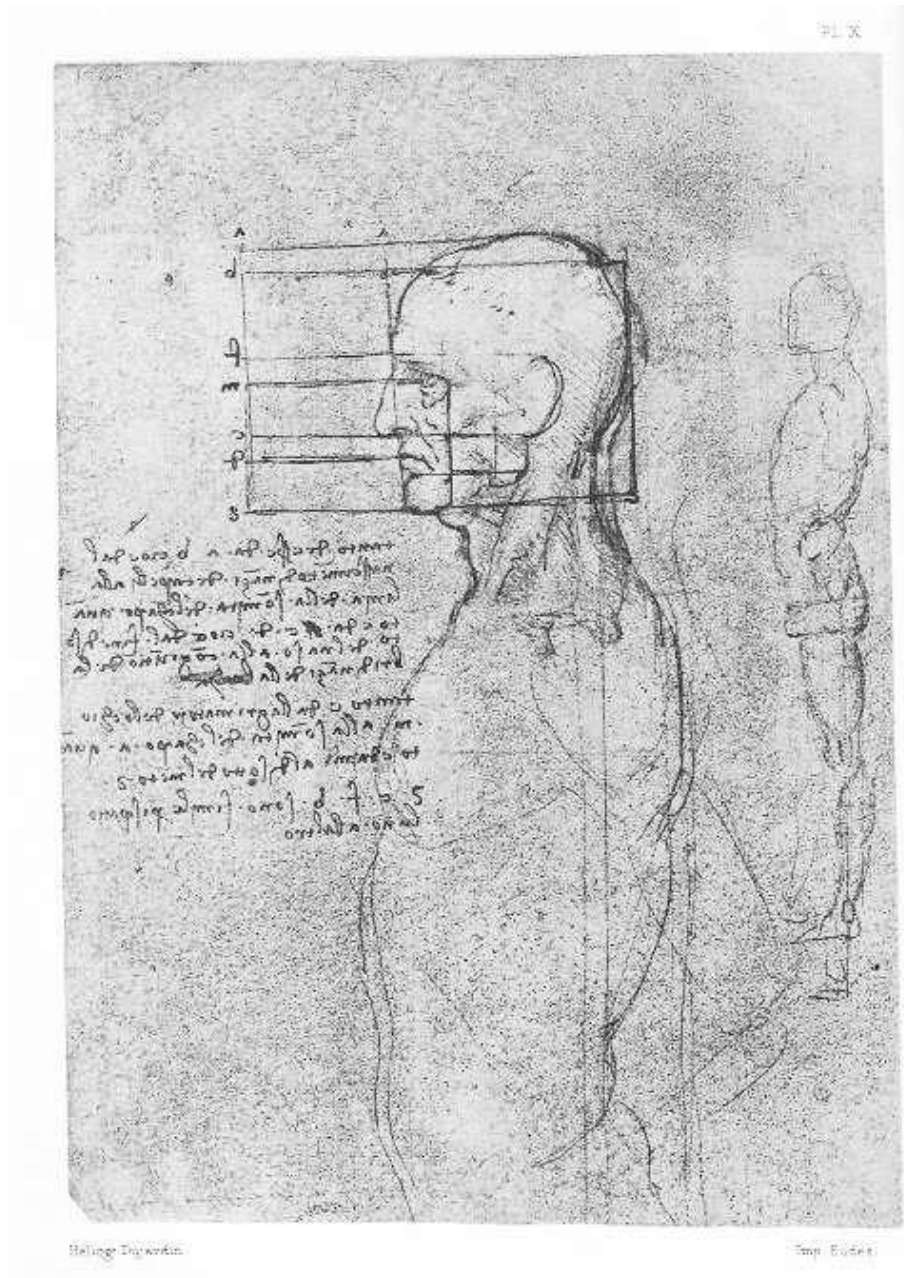


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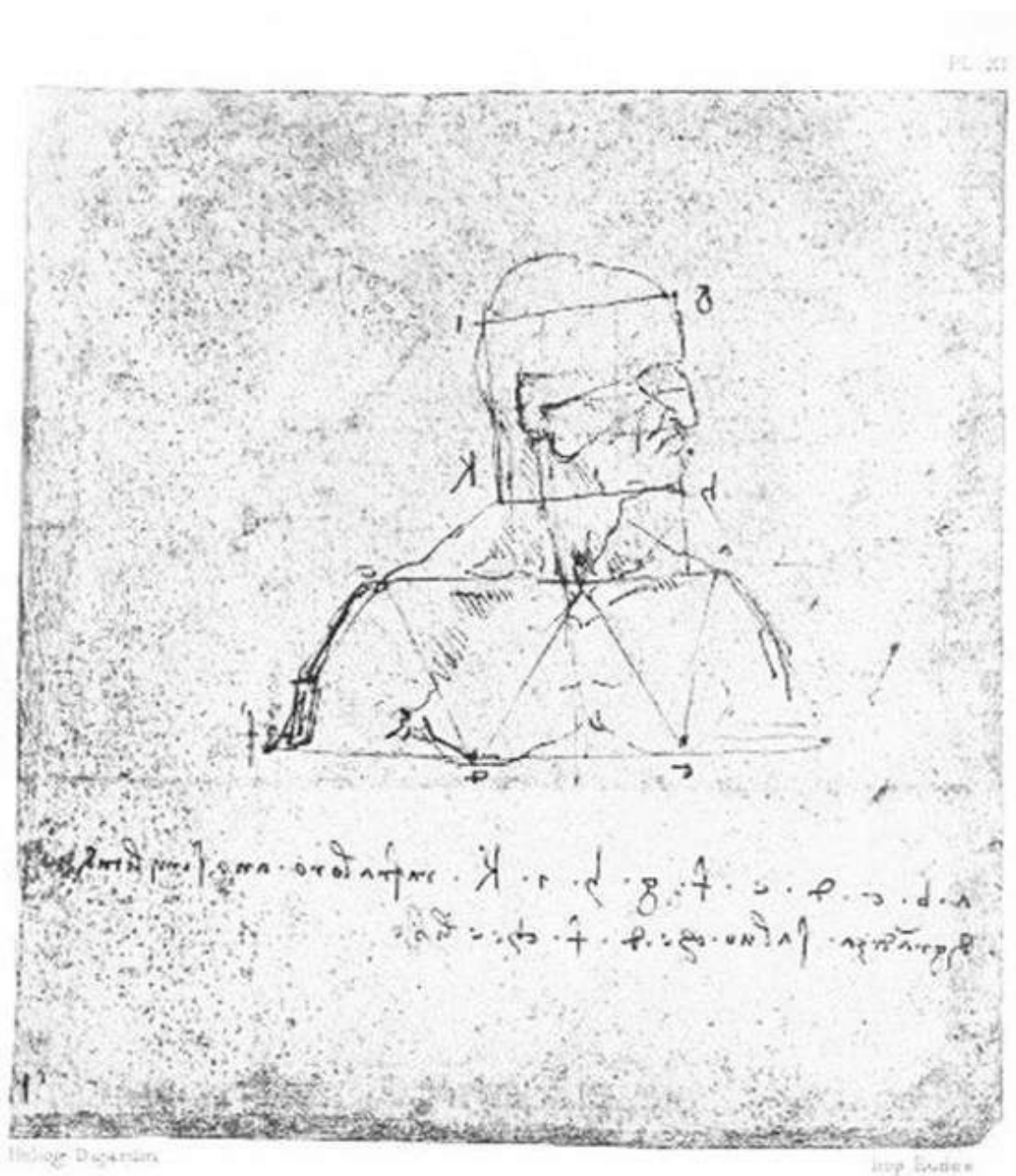


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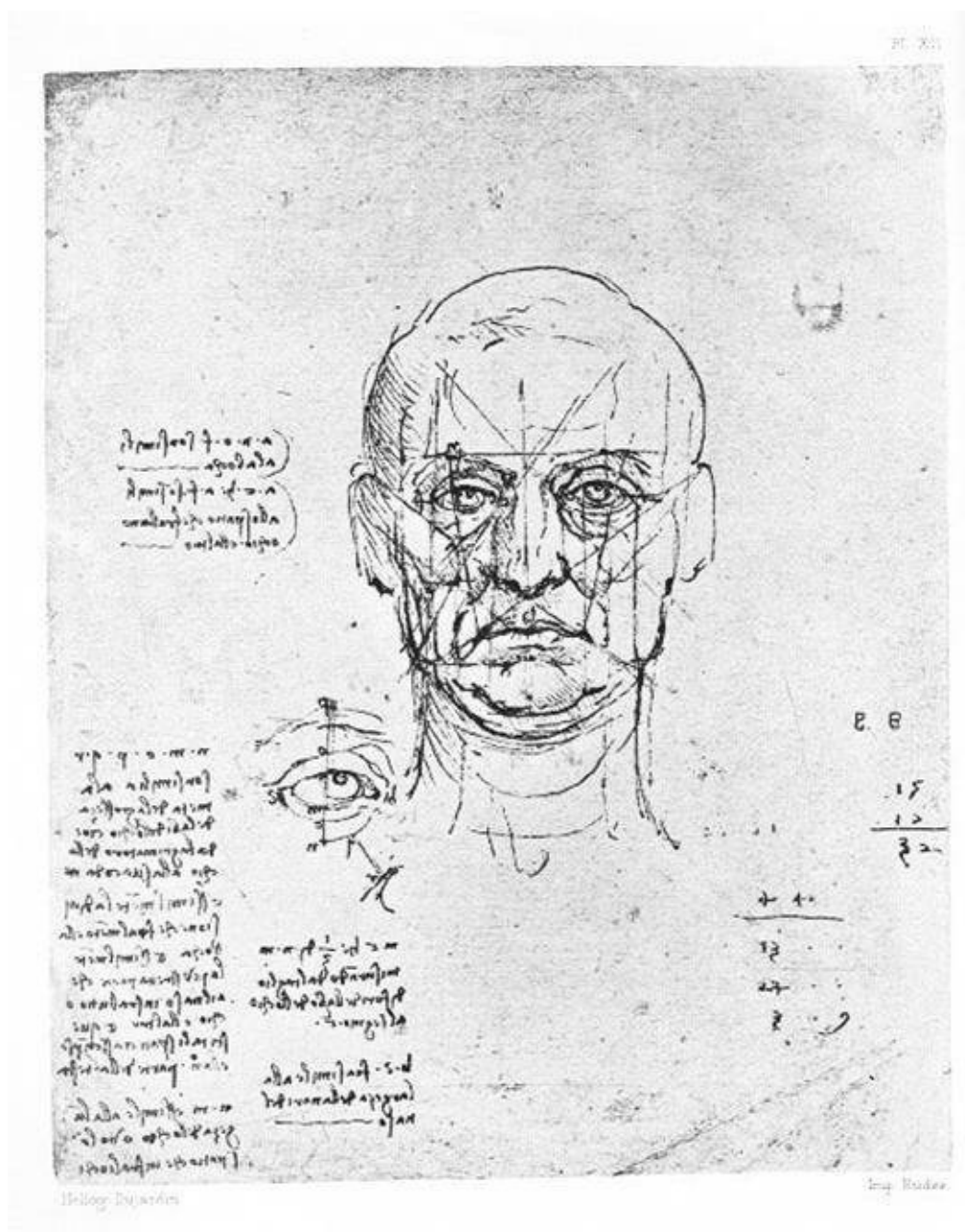


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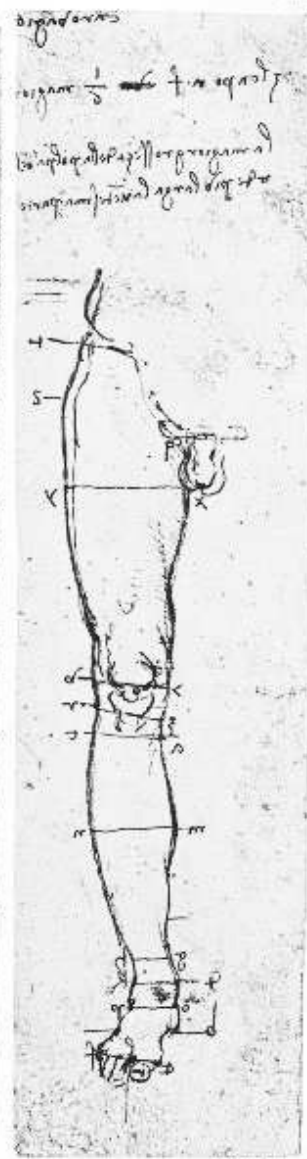
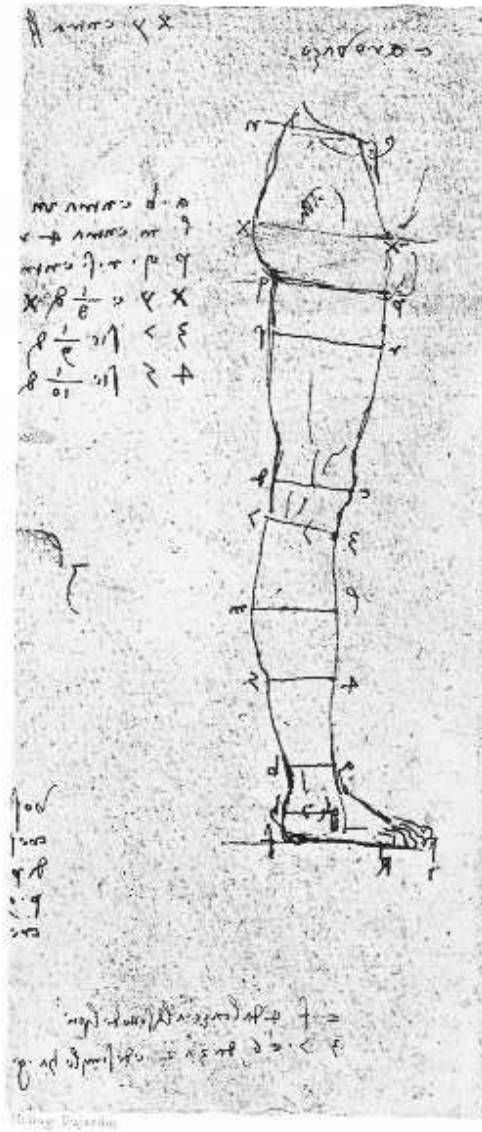


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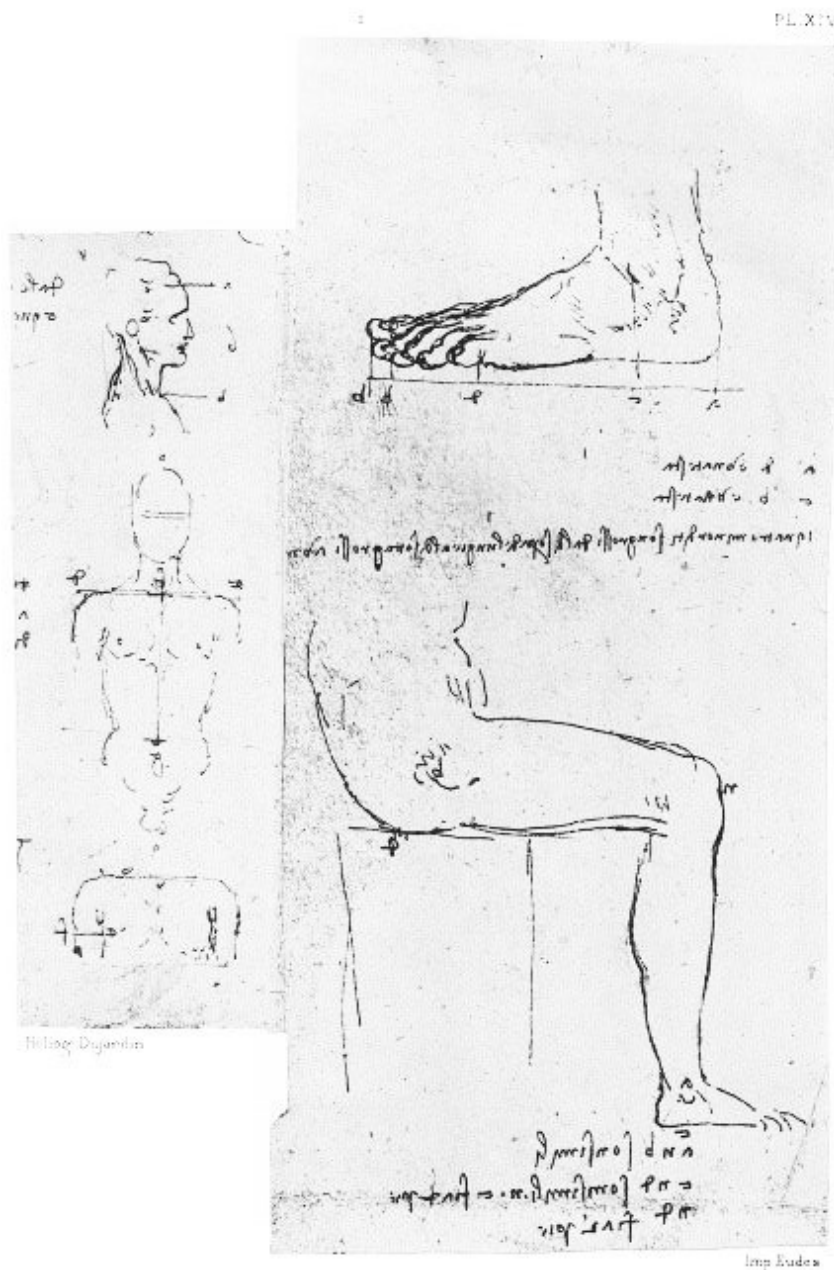


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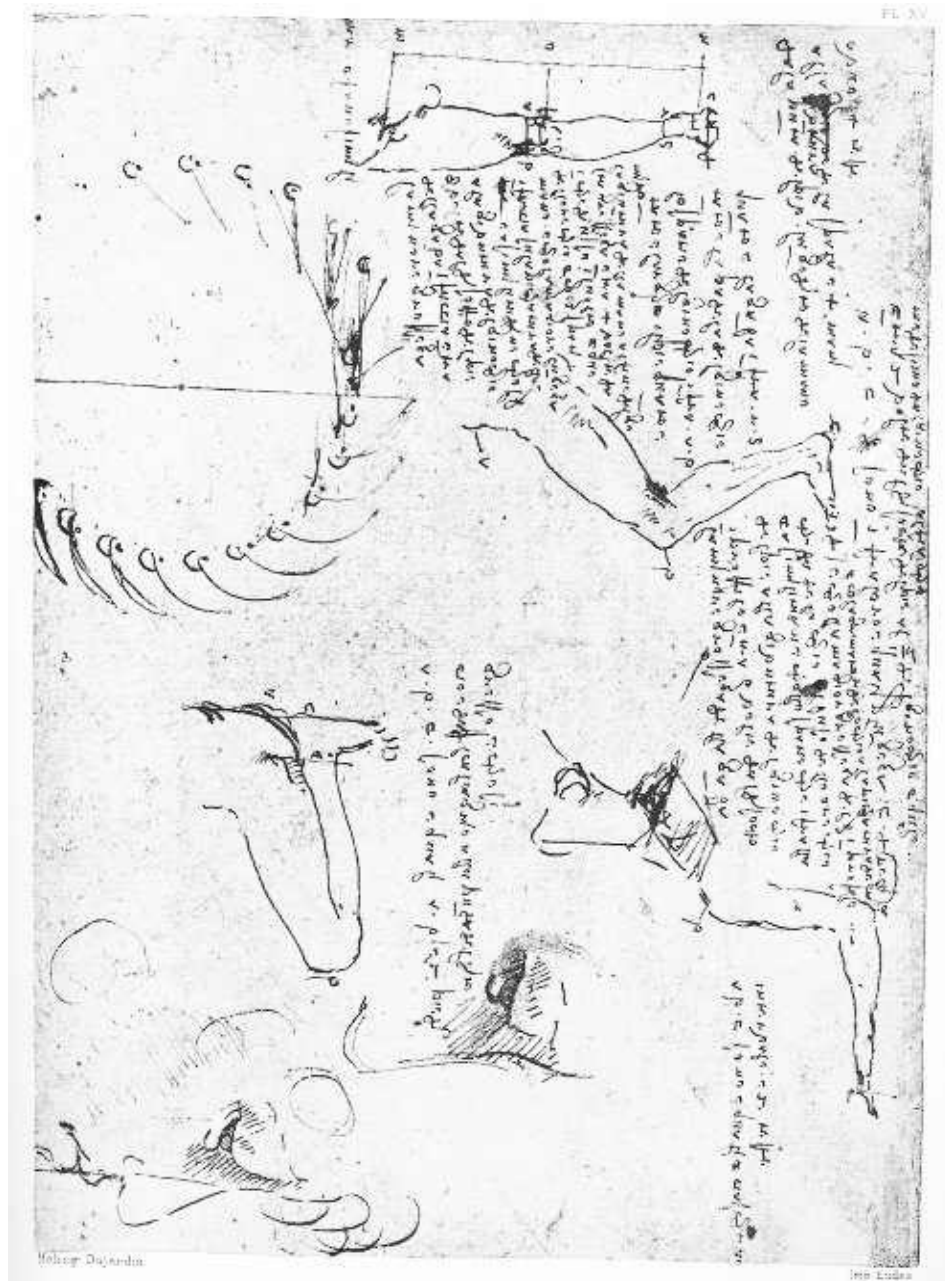


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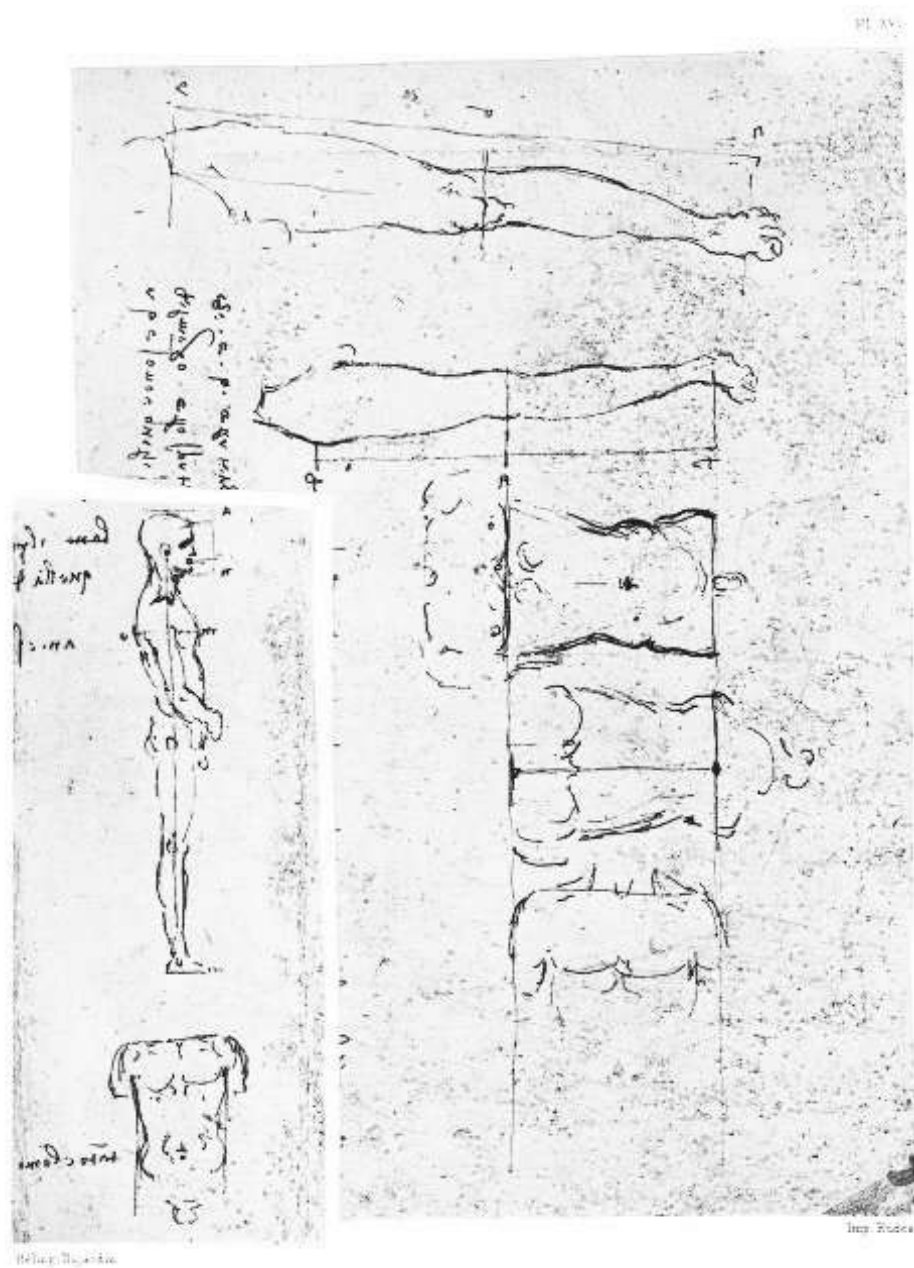


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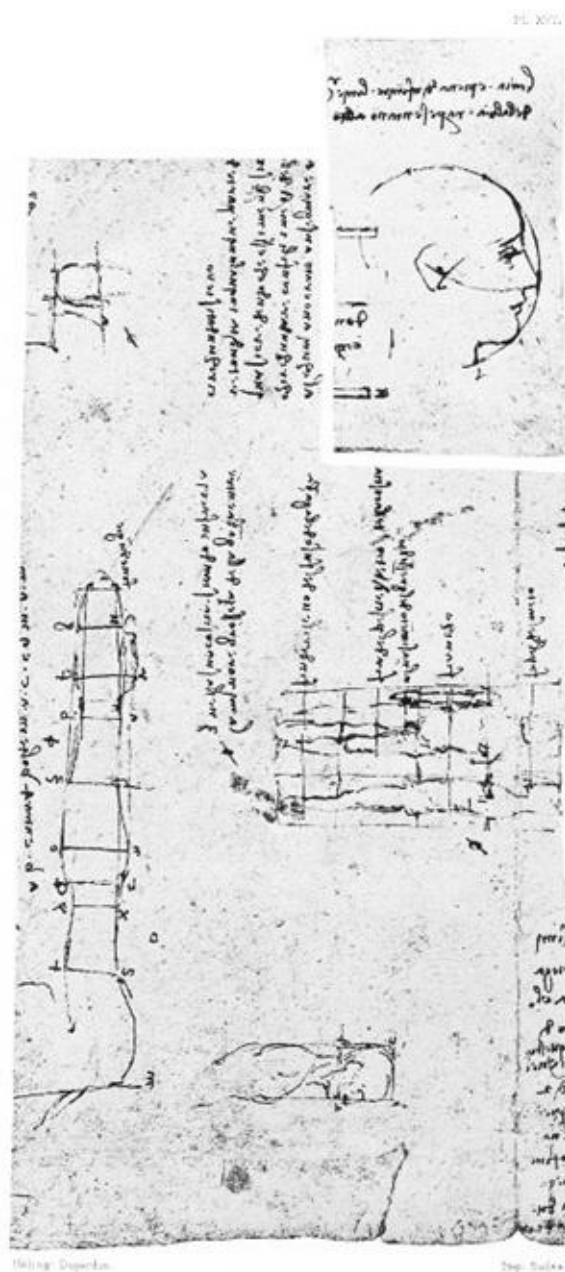


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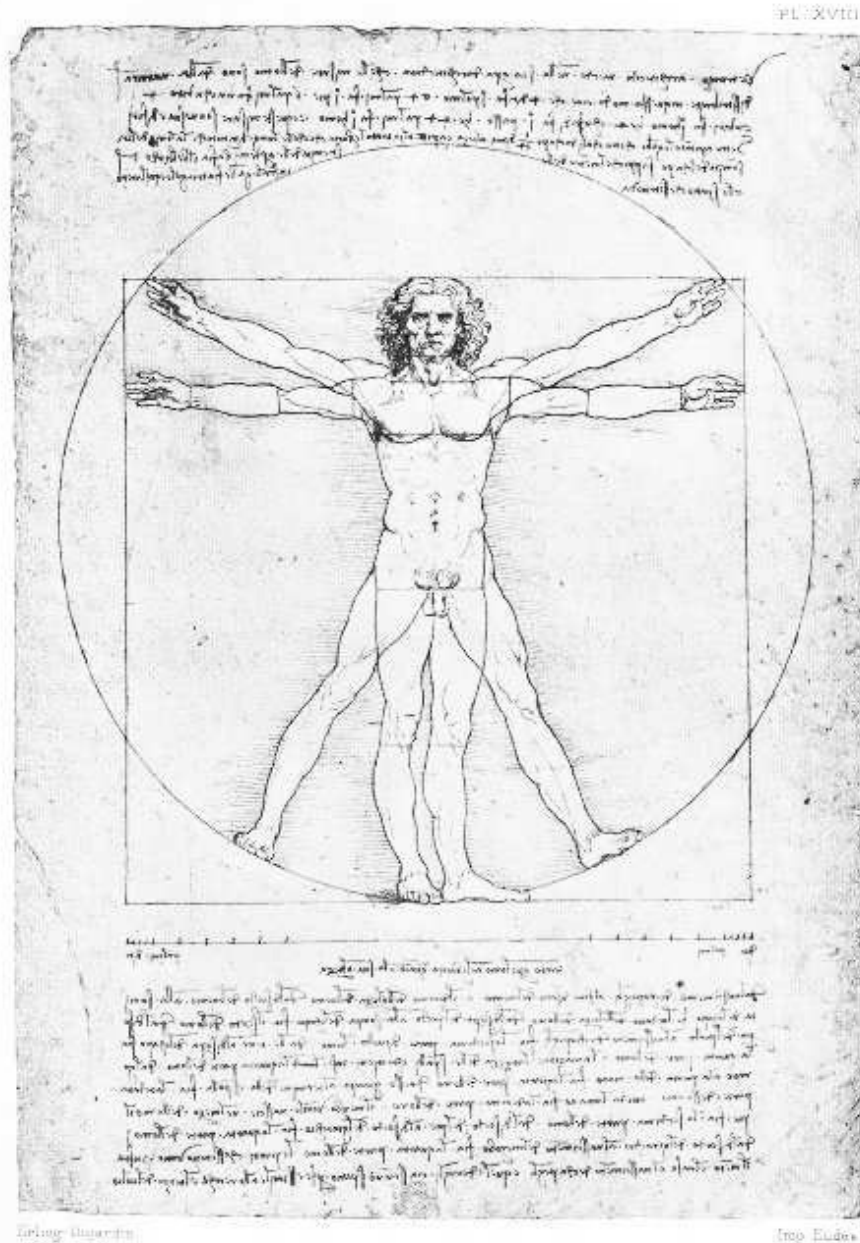
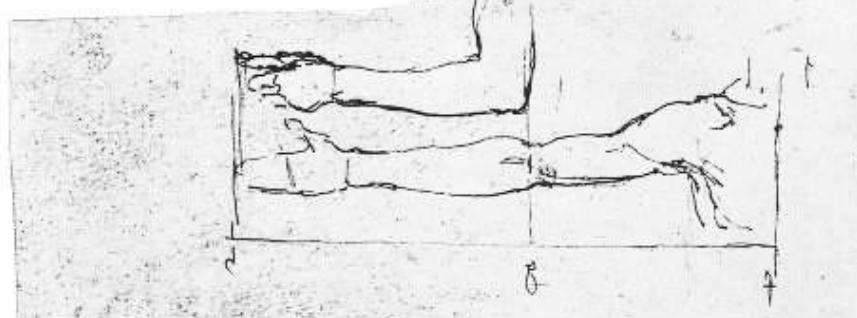
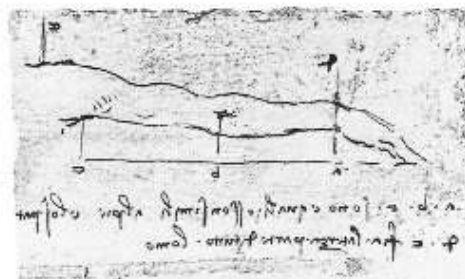


PLATE XIX

Pl. XIX



Polio. B. 1. 1. 1.

Imp. Eudex

PLATE XX

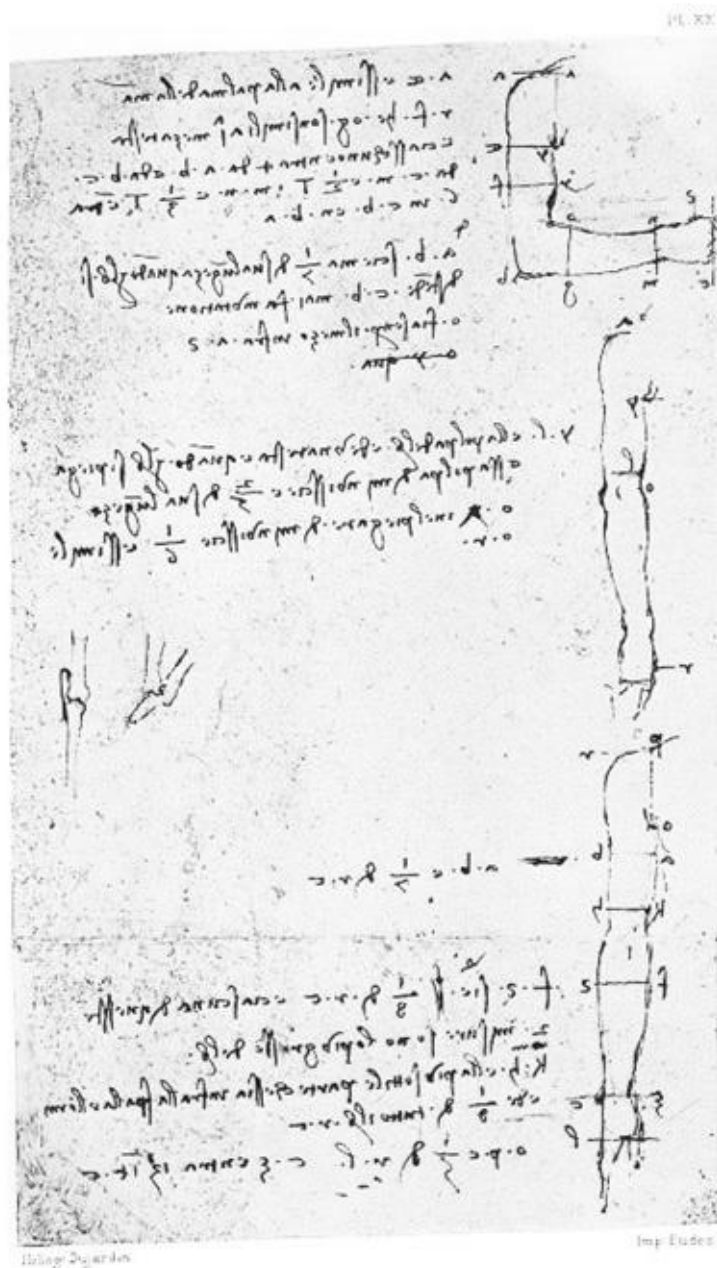
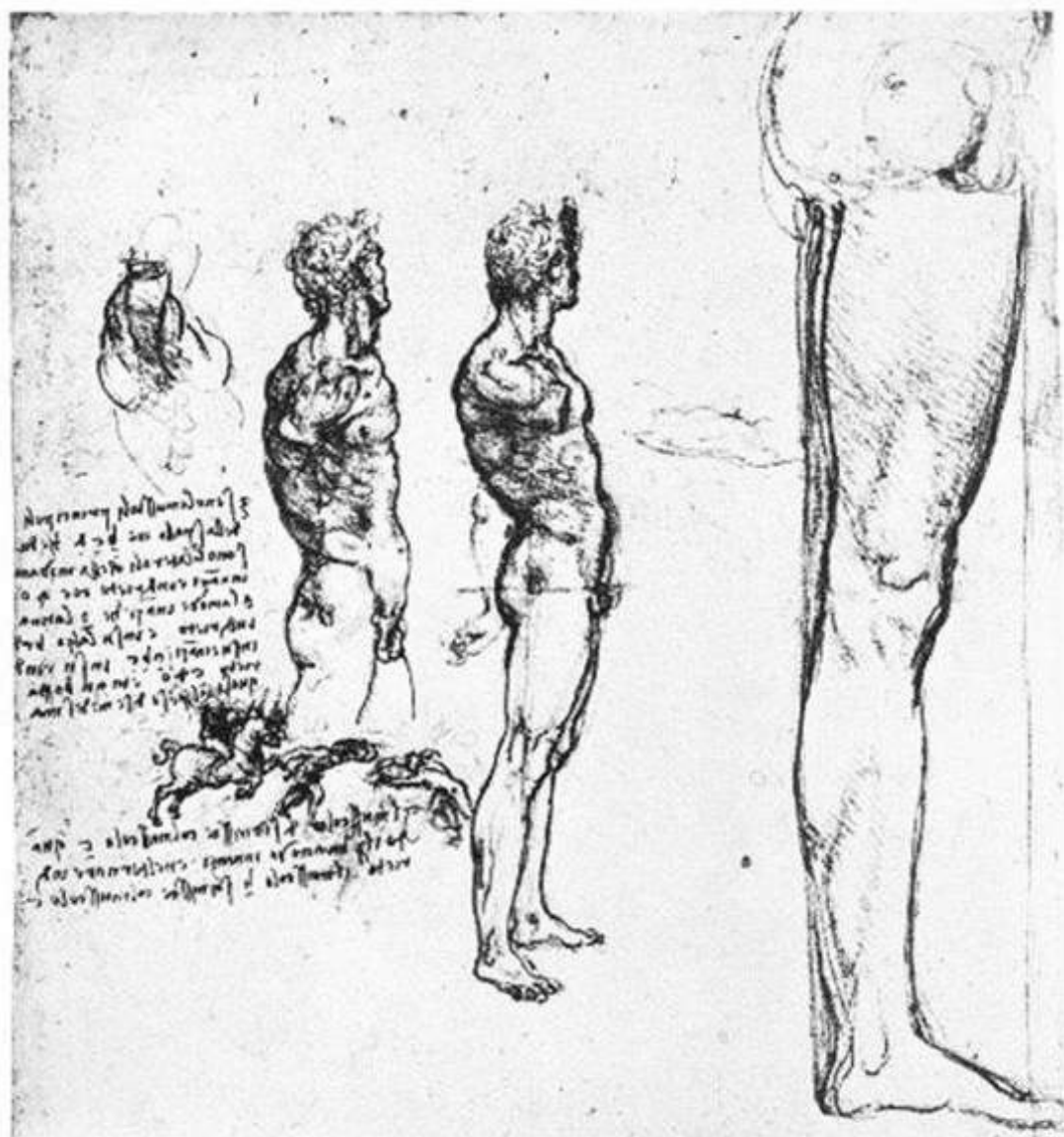


PLATE XXI



Et hoc Dupardis

Imo. H. 16. 16.

PLATE XXII



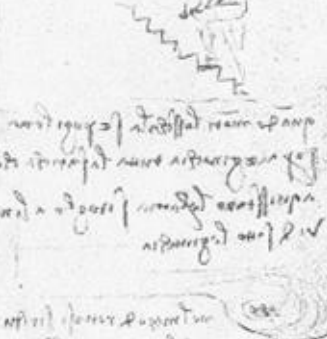
PLATE XXIII



Handwritten text in a cursive script, likely a transcription of a text from the manuscript.



Handwritten text in a cursive script, likely a transcription of a text from the manuscript.



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PLATE XXIV

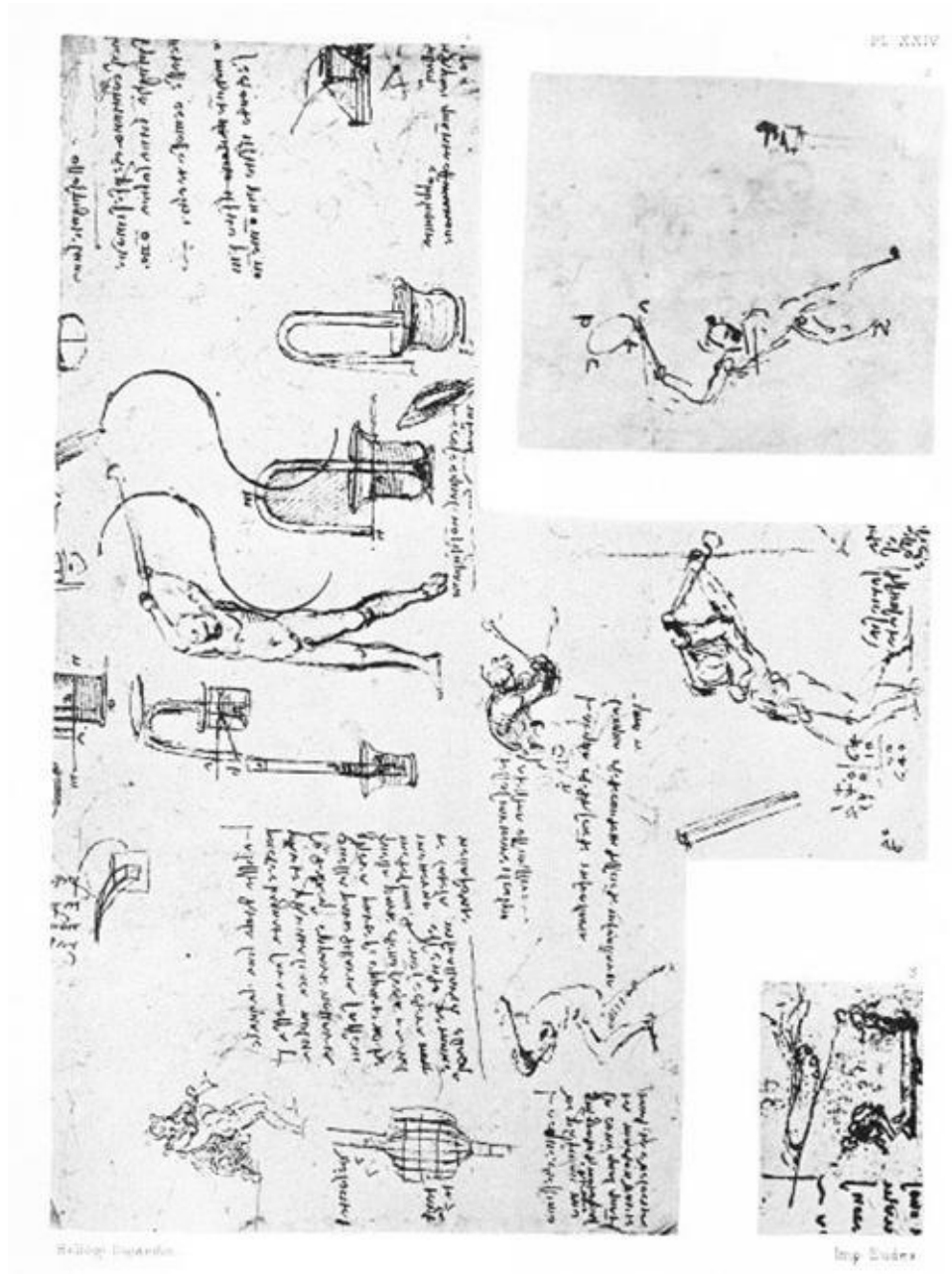


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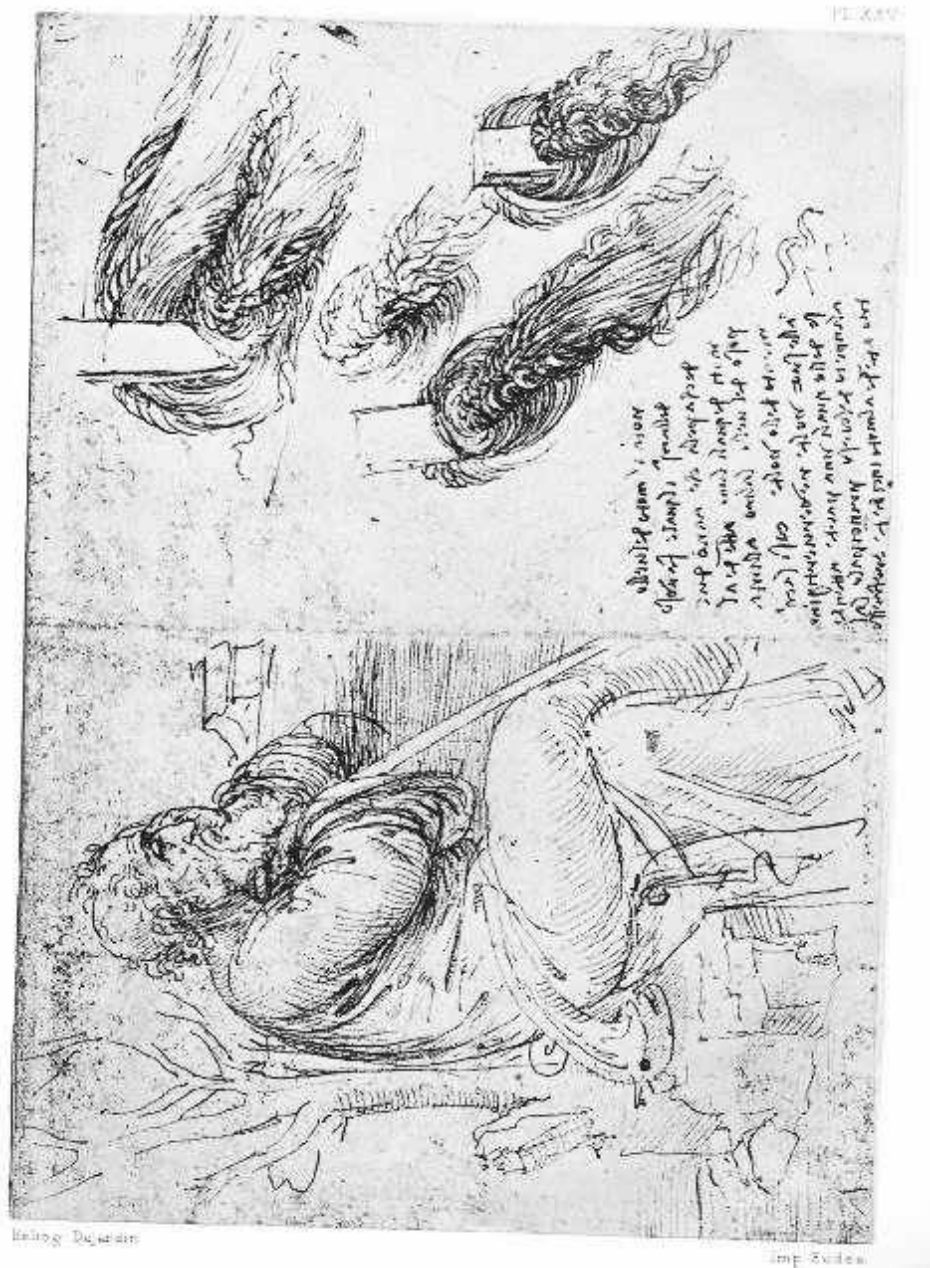


PLATE XXVI



W. H. R. H. H. H.

PL. XXVI

PLATE XXVII

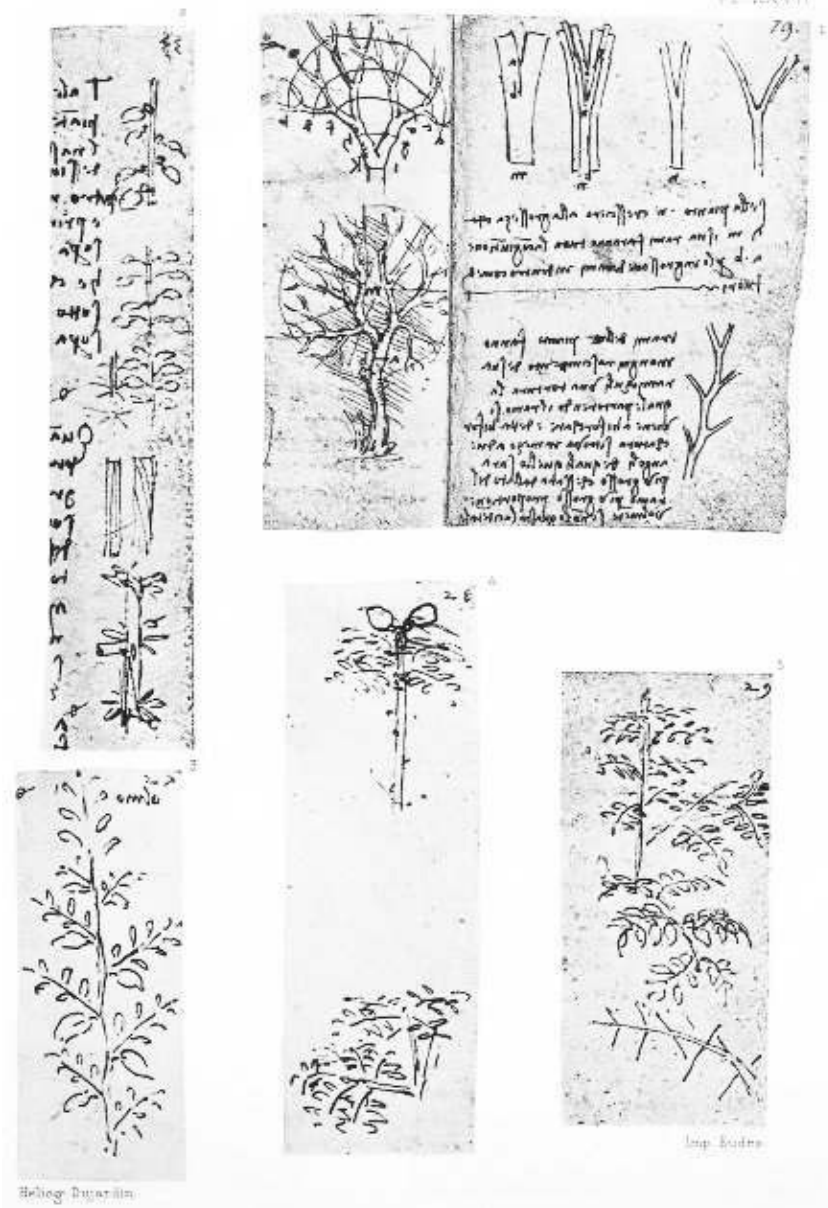


PLATE XXVIII



PLATE XXIX



Helwig Duerksen

Imp. F. 1880

PLATE XXX



PLATE XXXI

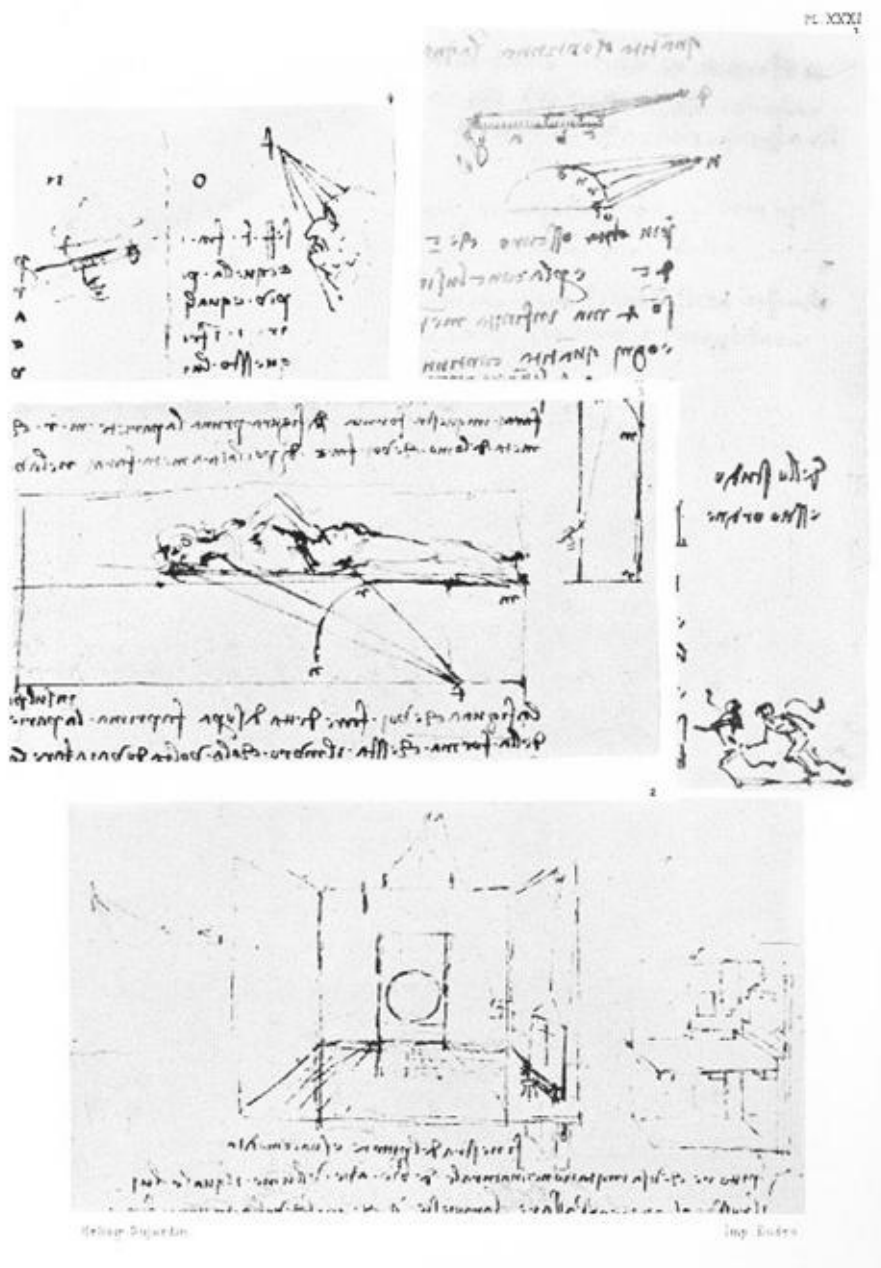


PLATE XXXII

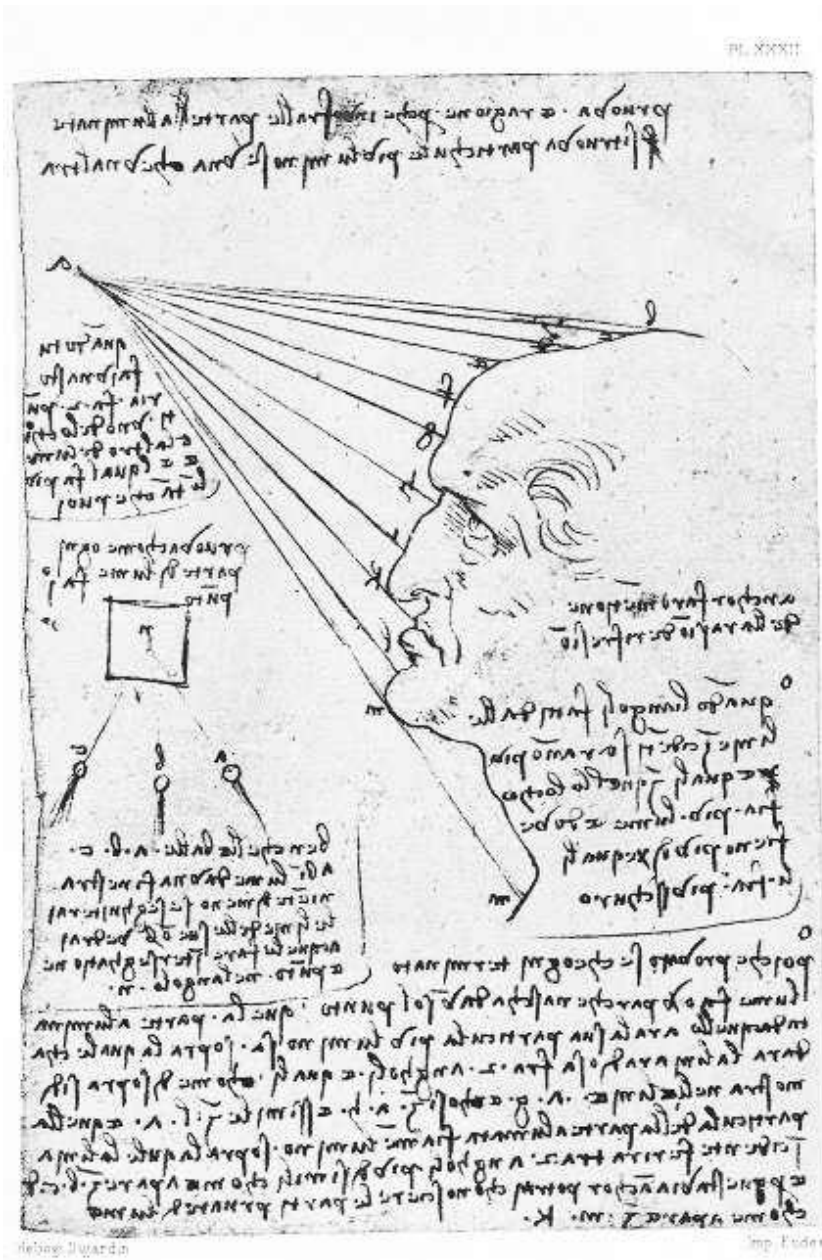


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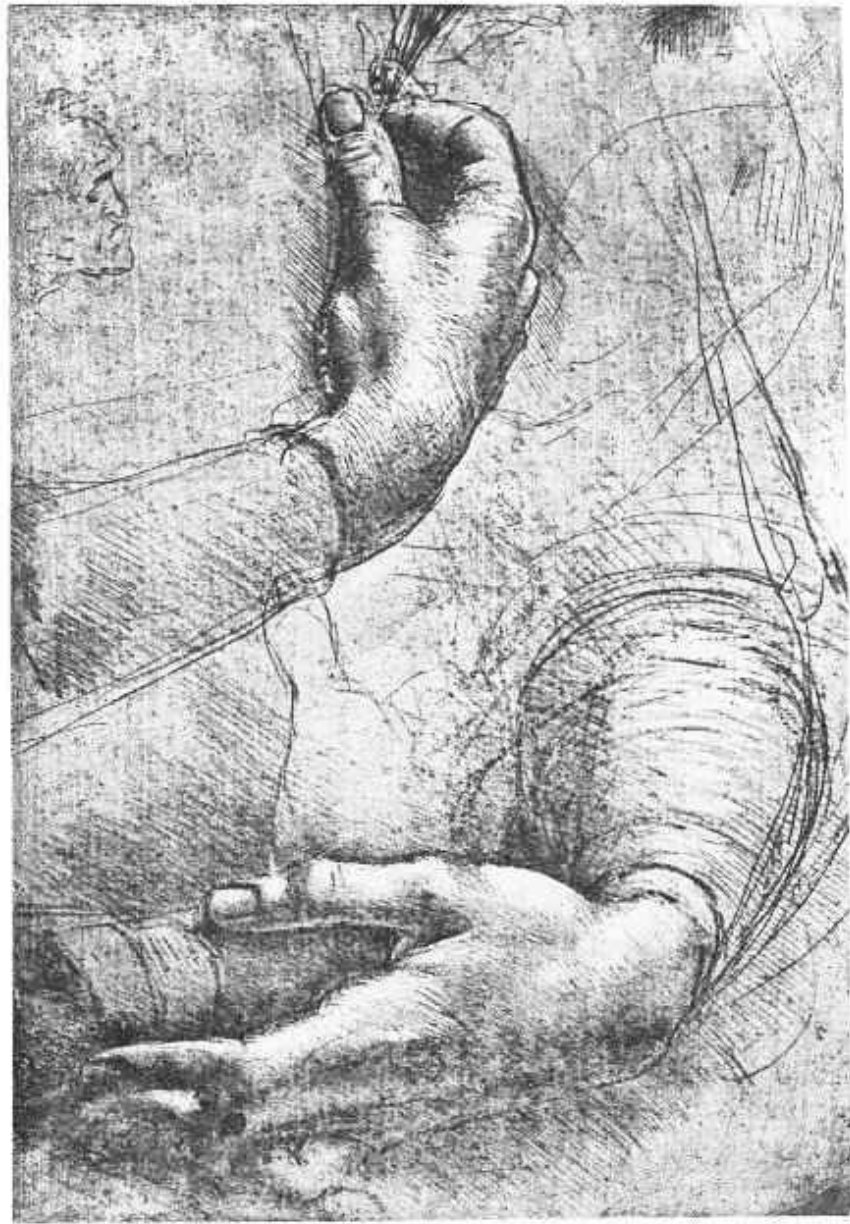


Fig. 1. 1789.

See Note.

PLATE XXXIV

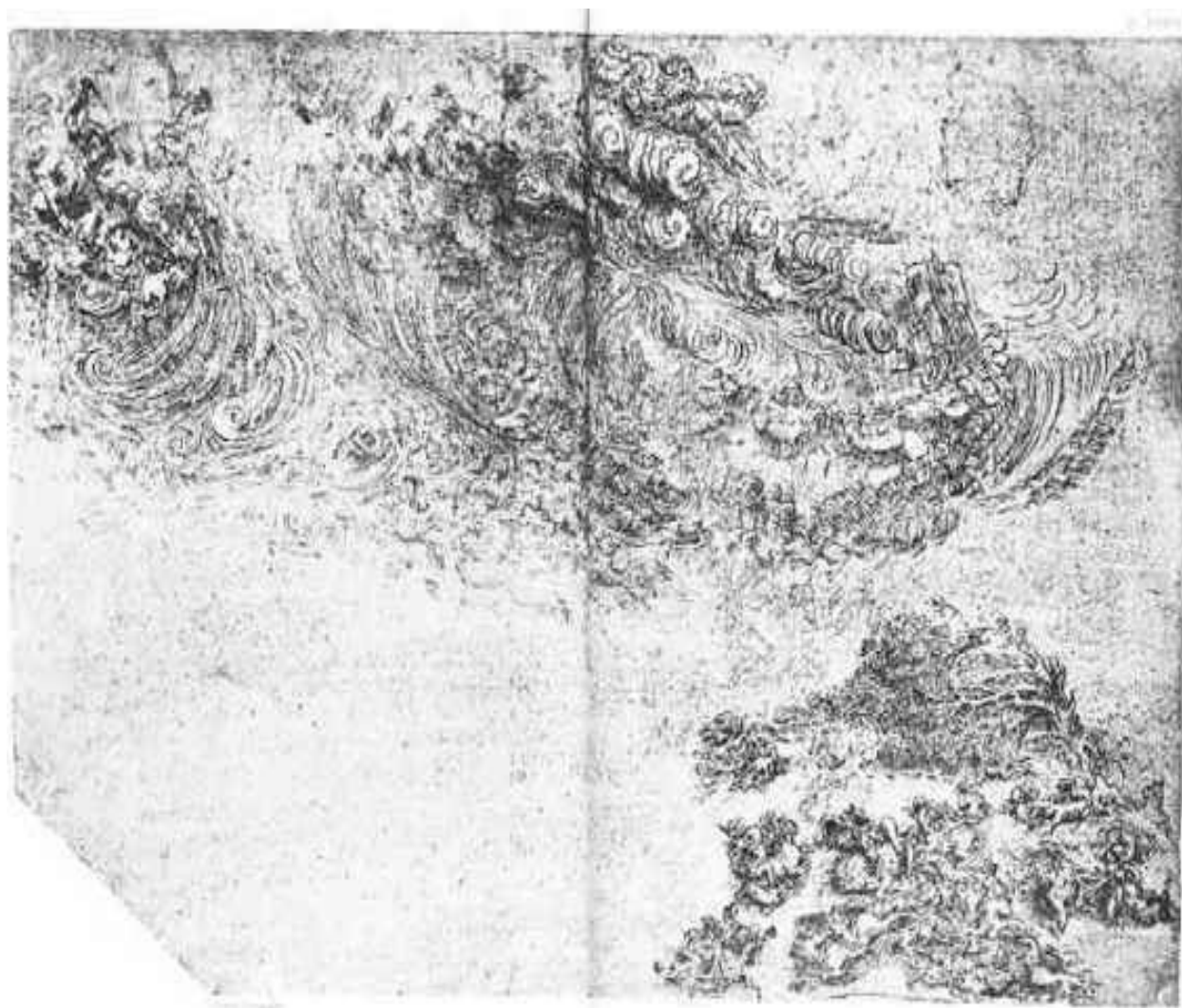


PLATE XXXV



PLATE XXXVI

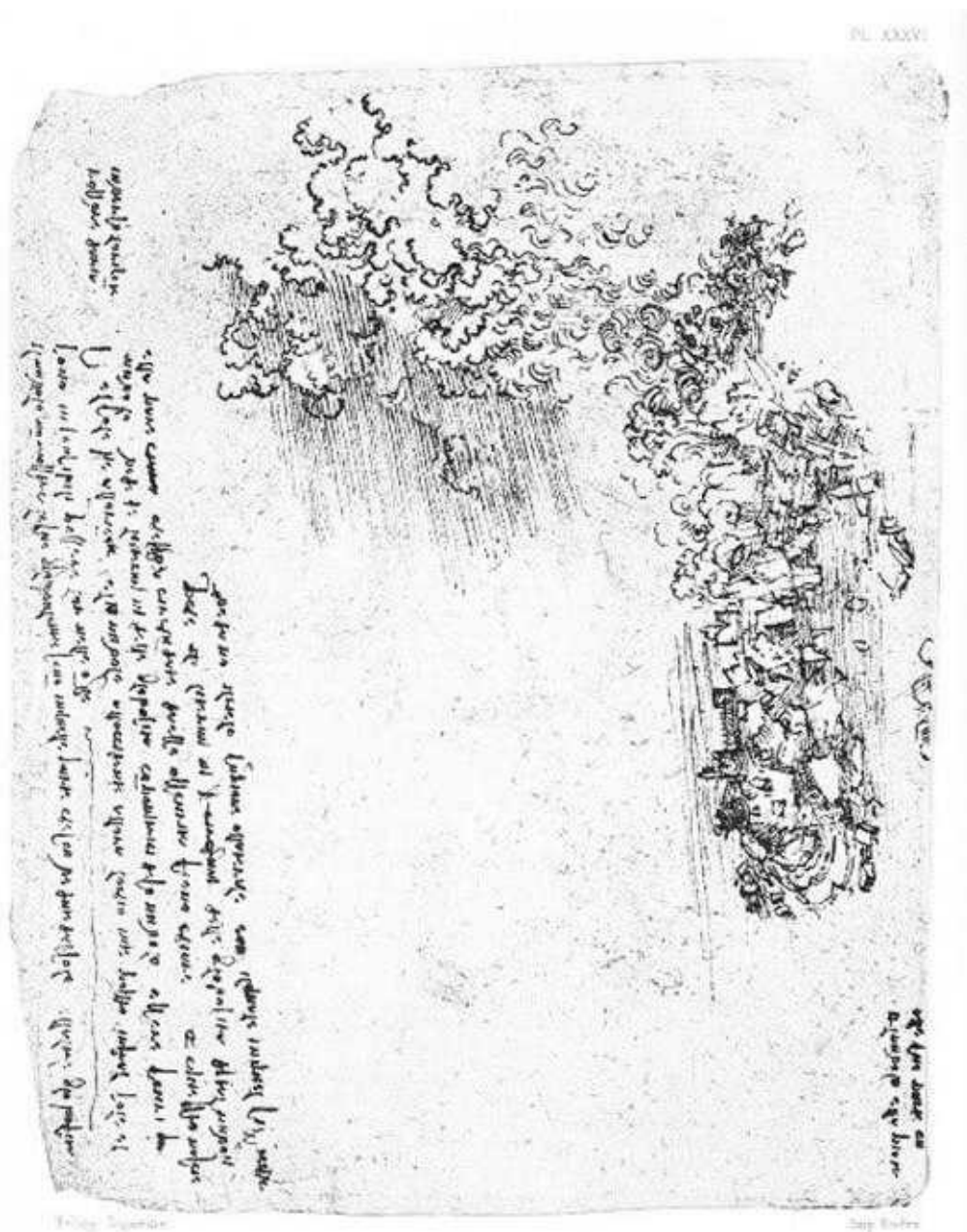


PLATE XXXVII



For the
Landscape
of the
Landscape
of the
Landscape

PLATE XXXVIII



PLATE XXXIX



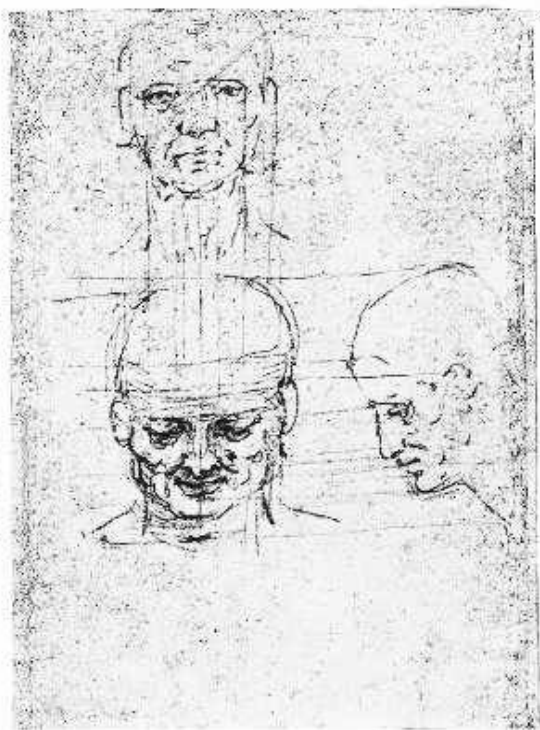
Unio Dupondii

Unio Eadesii

PLATE XL



Relief, Darius I



Imp. Euseb

PLATE XLI

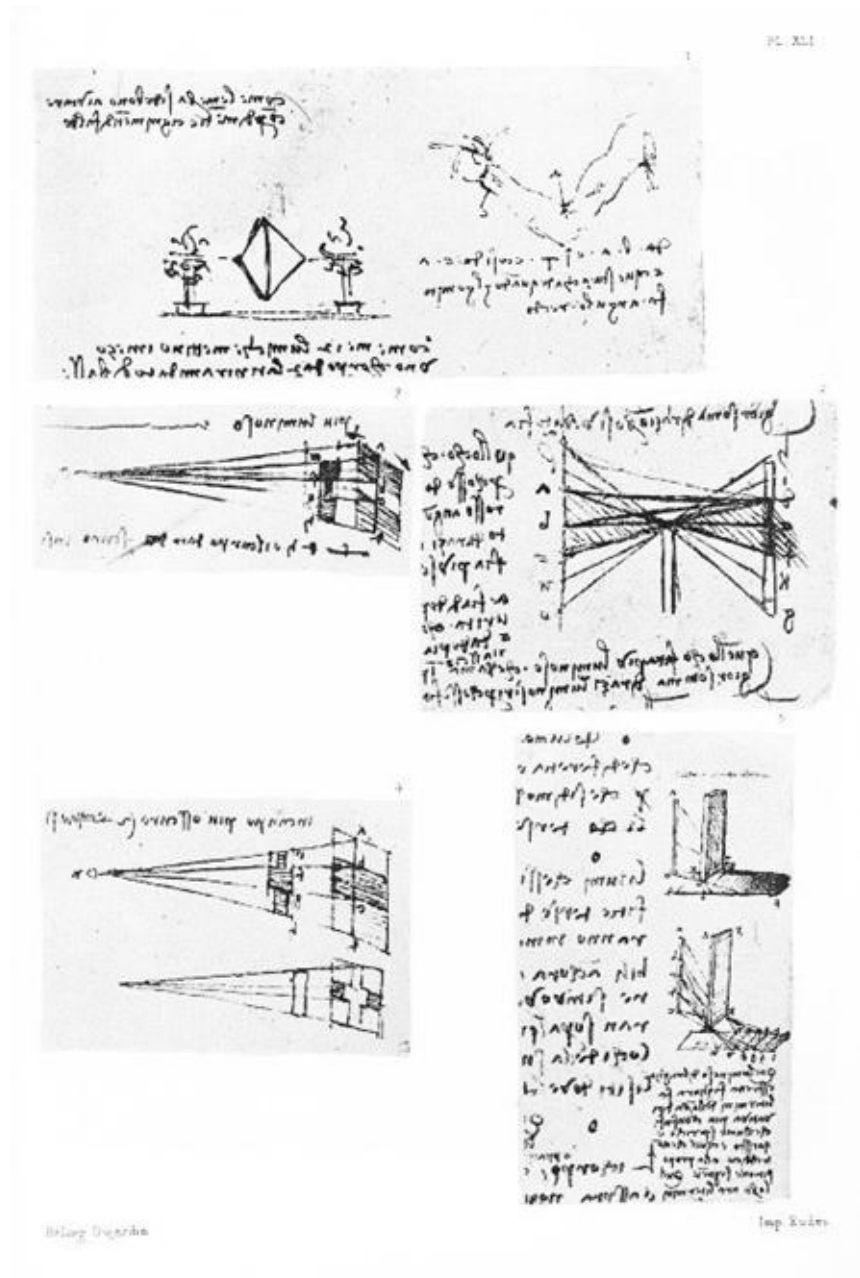


PLATE XLII



Museo Borghese

Don. Luce

PLATE XLIII



PLATE XLIV

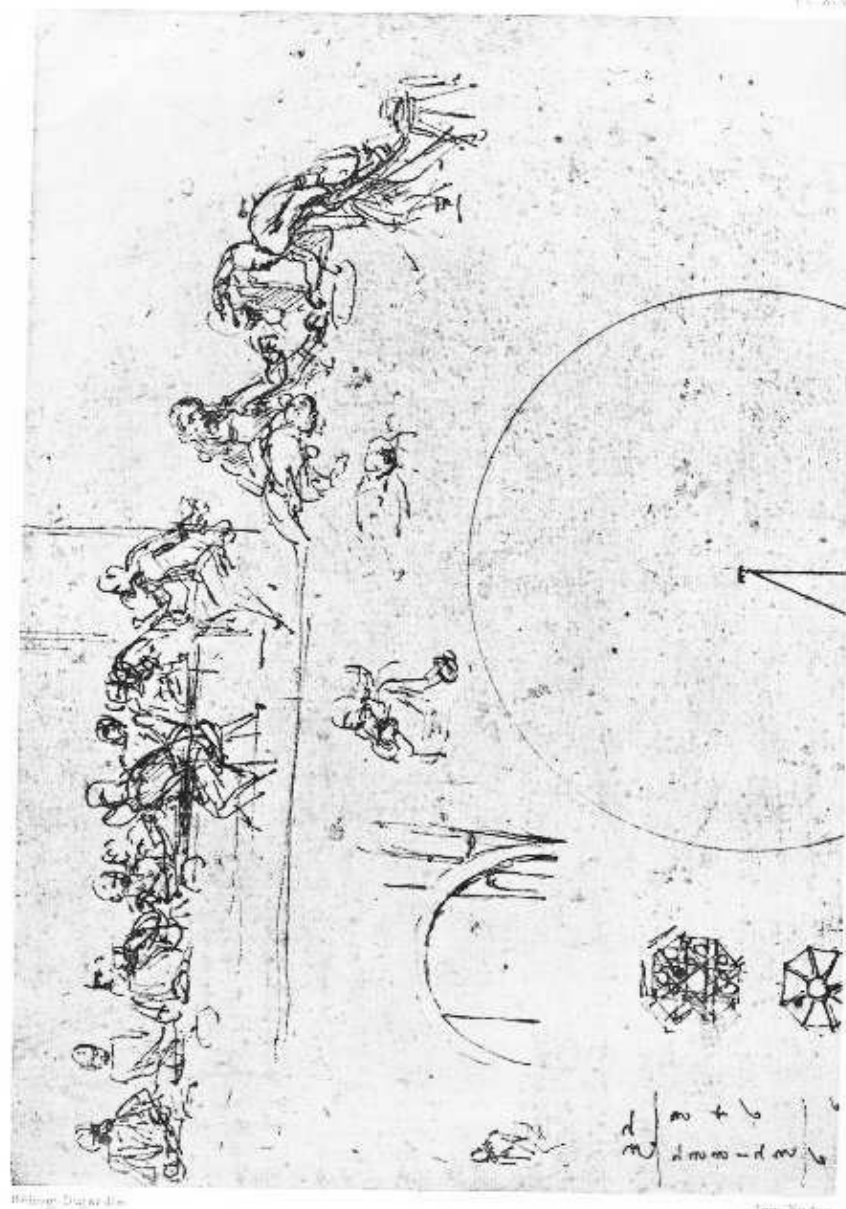
PL XLIV



Heliog. Dujardin.

Imp. Eudes

PLATE XLV



Belmont, D. 100. 100

[unclear] 100. 100

PLATE XLVI

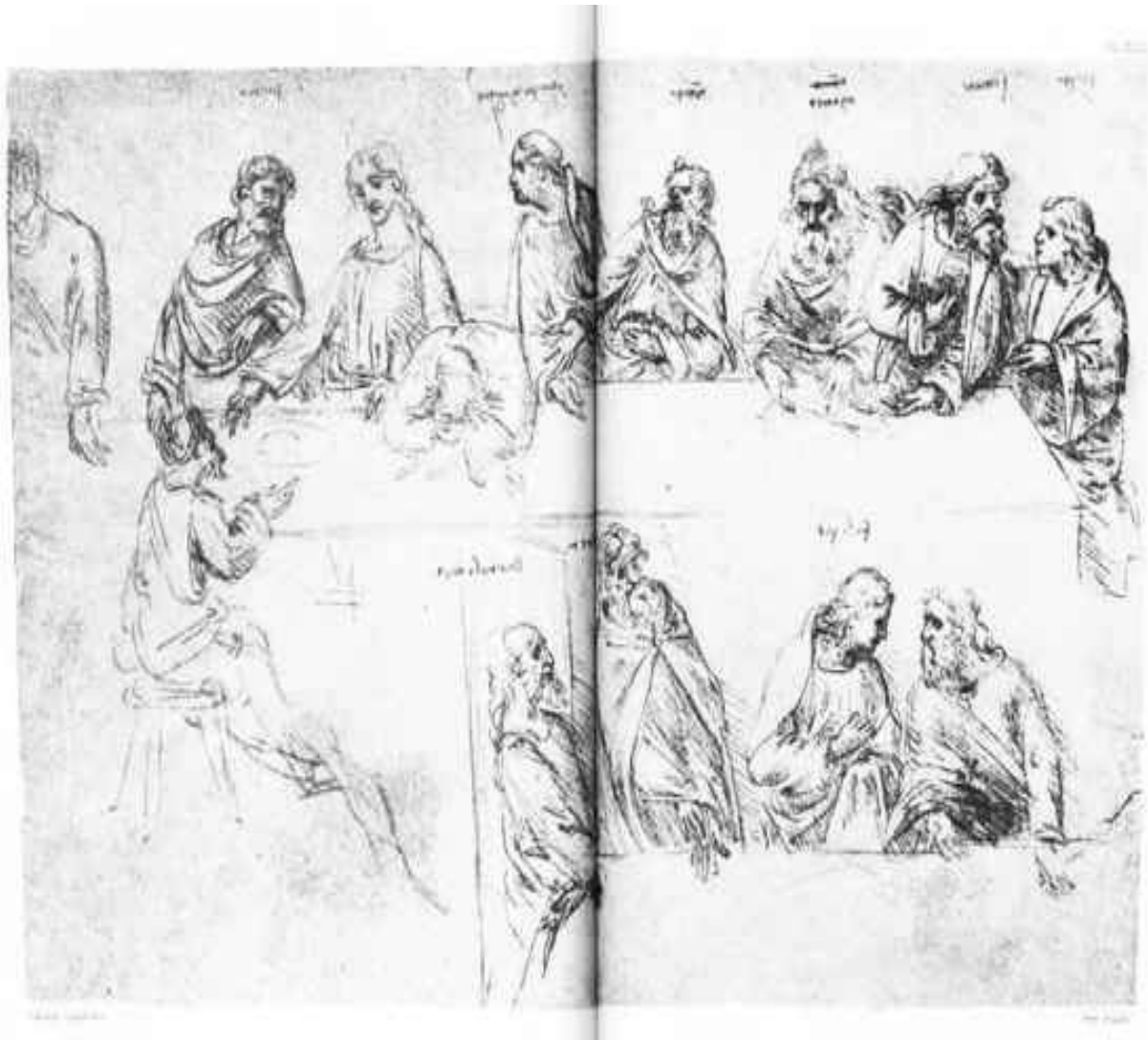


PLATE XLVII



PLATE XLVIII



PLATE XLIX



Antony van Dyck

Fig. 1. 1. 1.

PLATE L



PLATE LI



PLATE LII



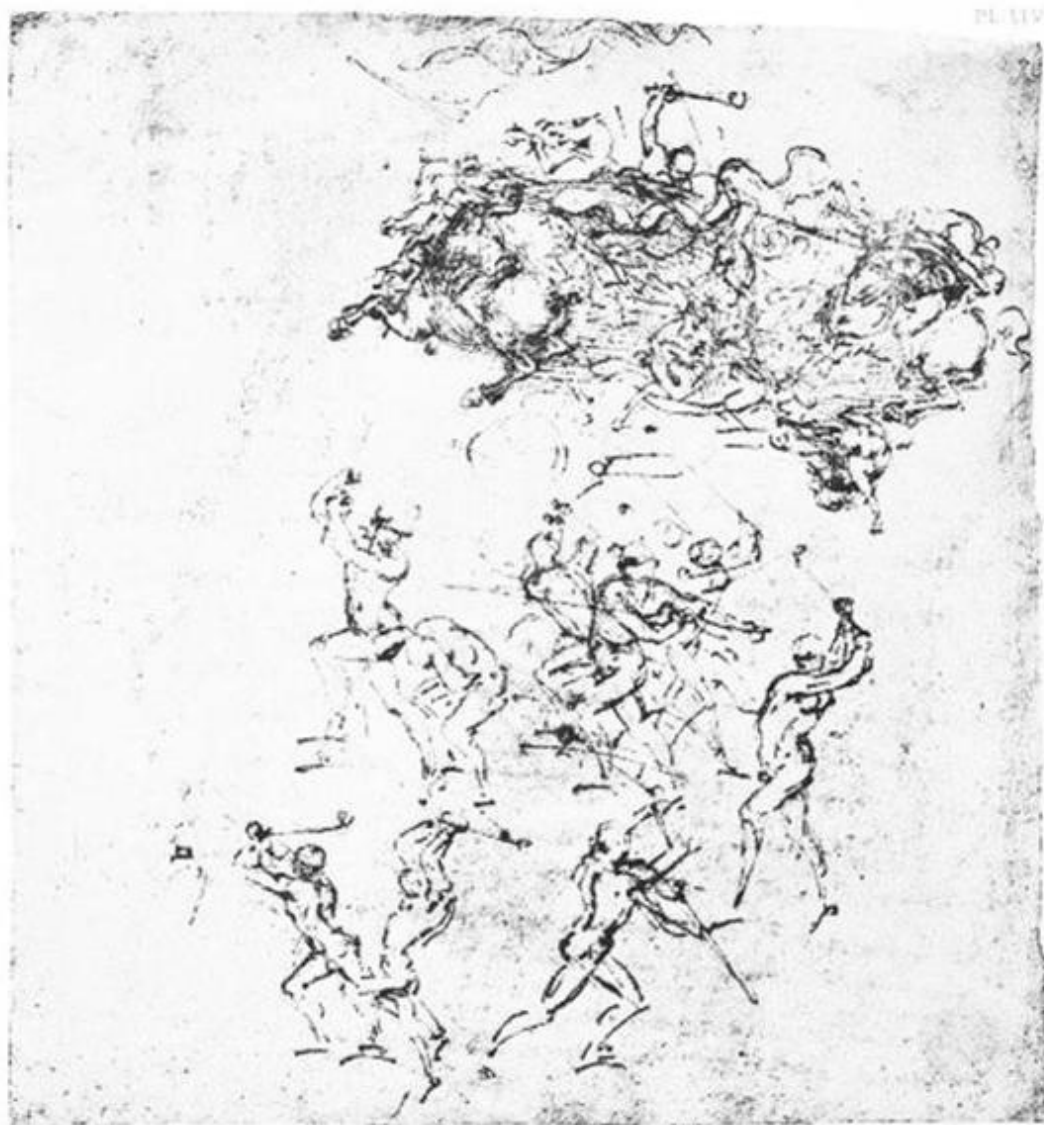
Henry Dujardin

Eng. E. L. L.

PLATE LIII



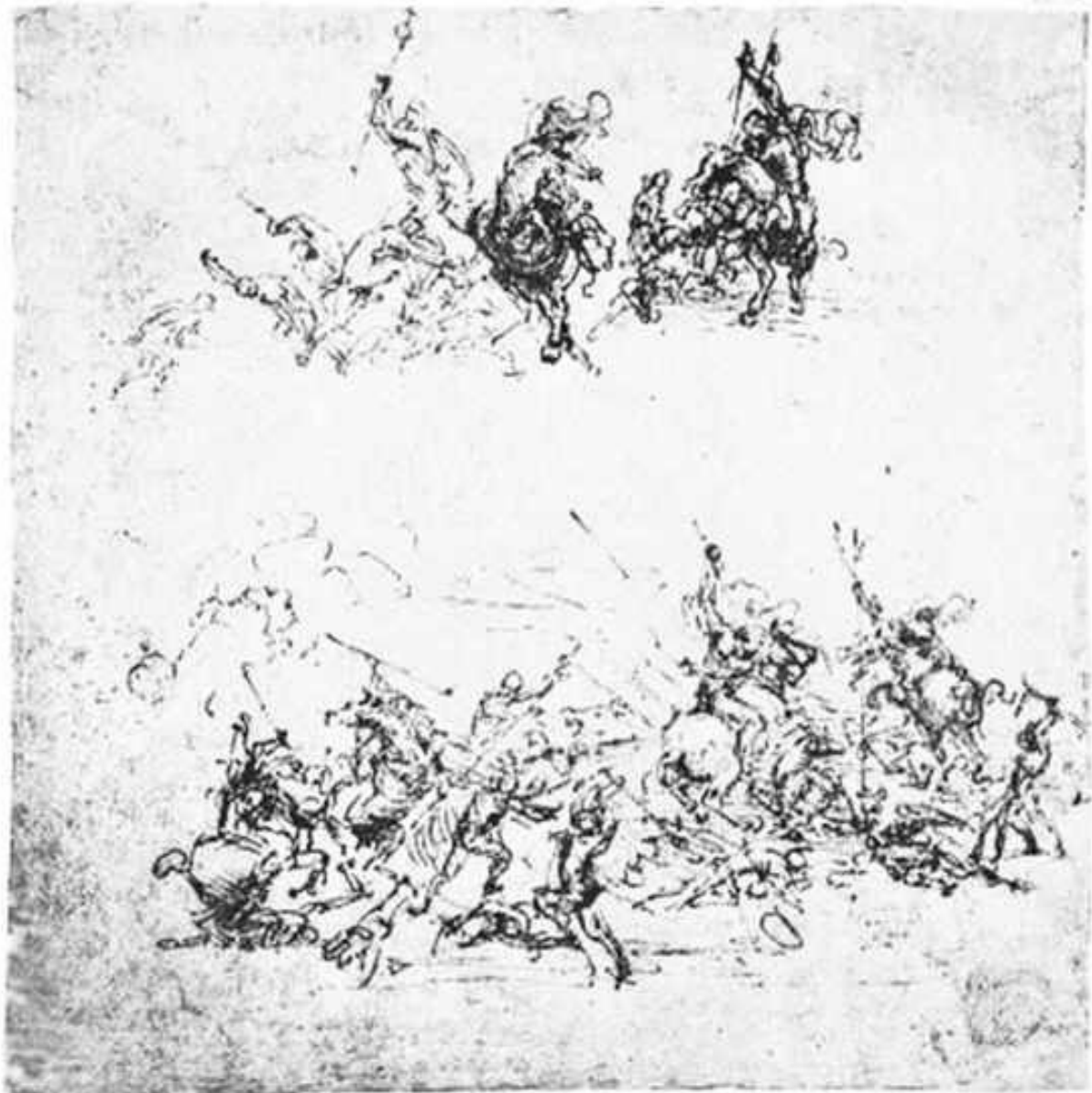
PLATE LIV



Holmes & Wadsworth

Imp. 2000

PLATE LV



Plato, Sicardus

The East

PLATE LVI



PLATE LVII

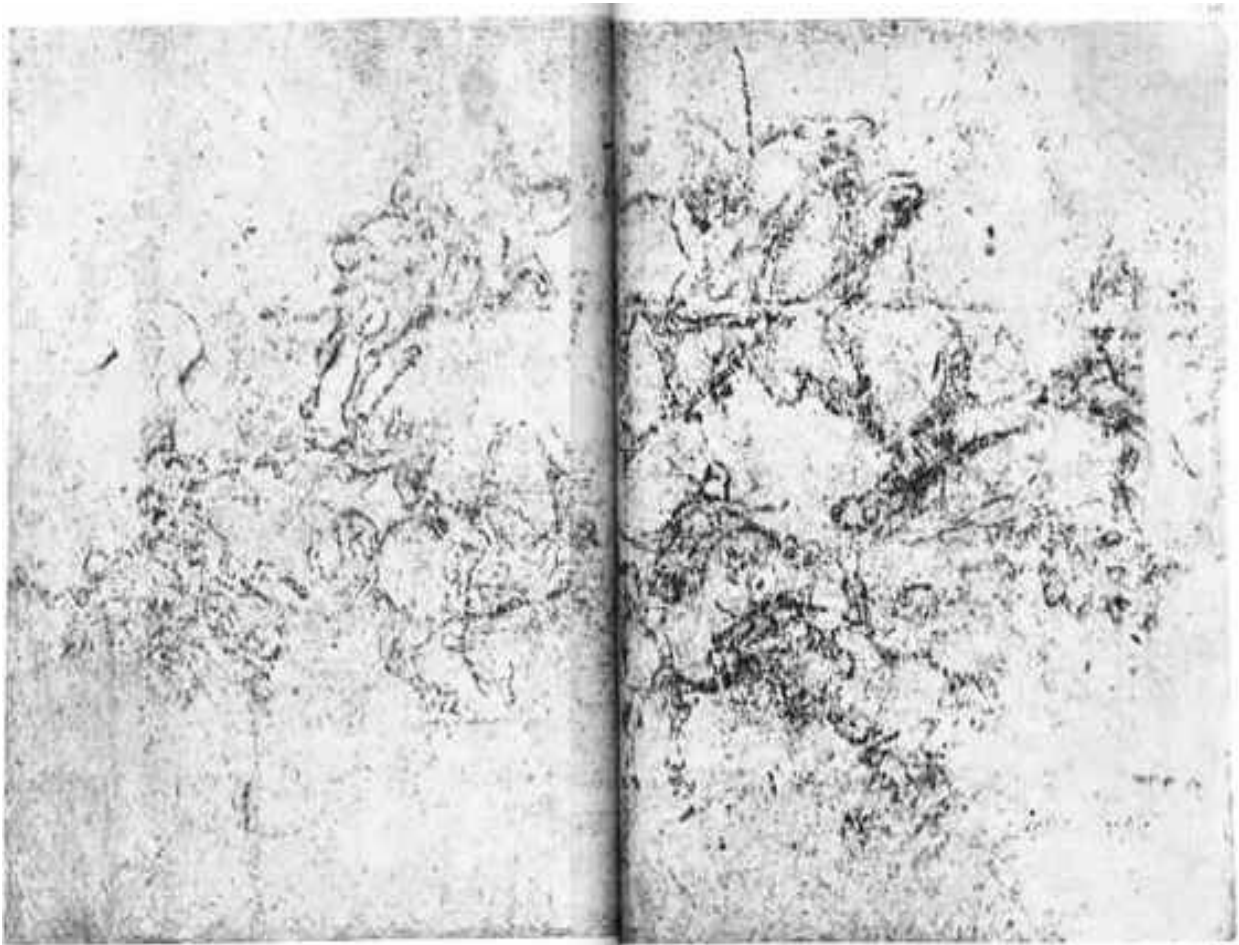
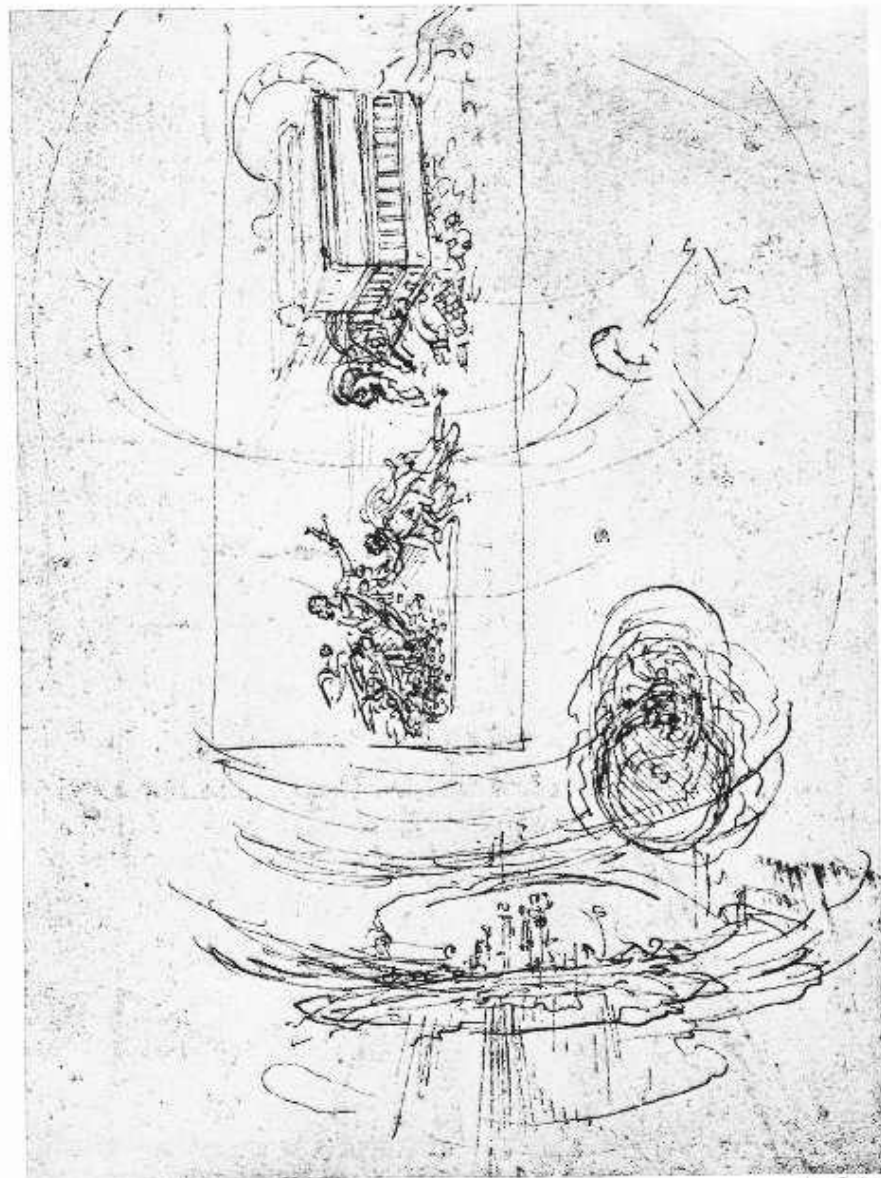


PLATE LVIII



Holten-Dupont

Imp. Eude

PLATE LIX

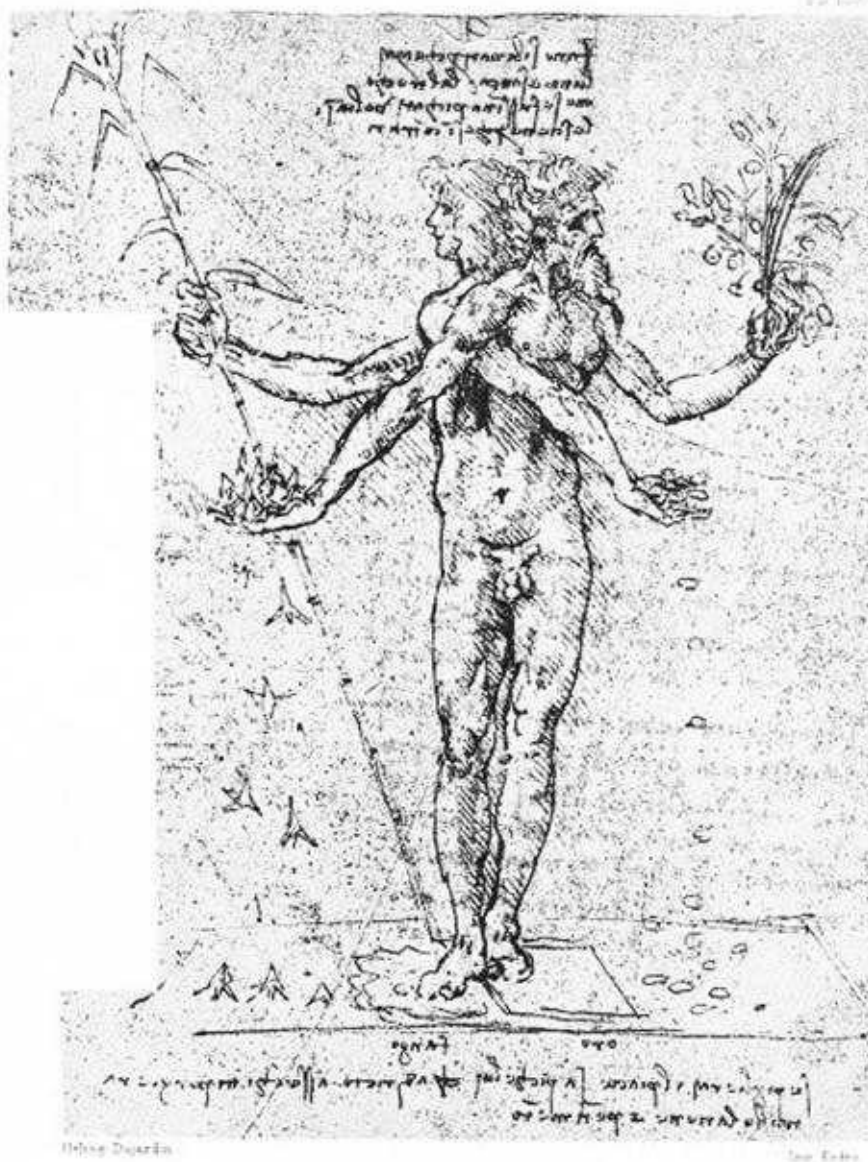


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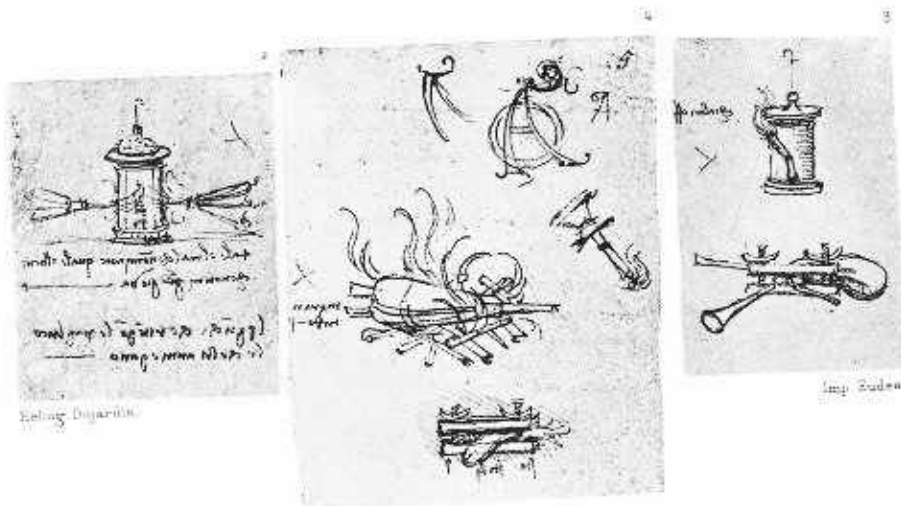


PLATE LXI



PLATE LXII



PLATE LXIII

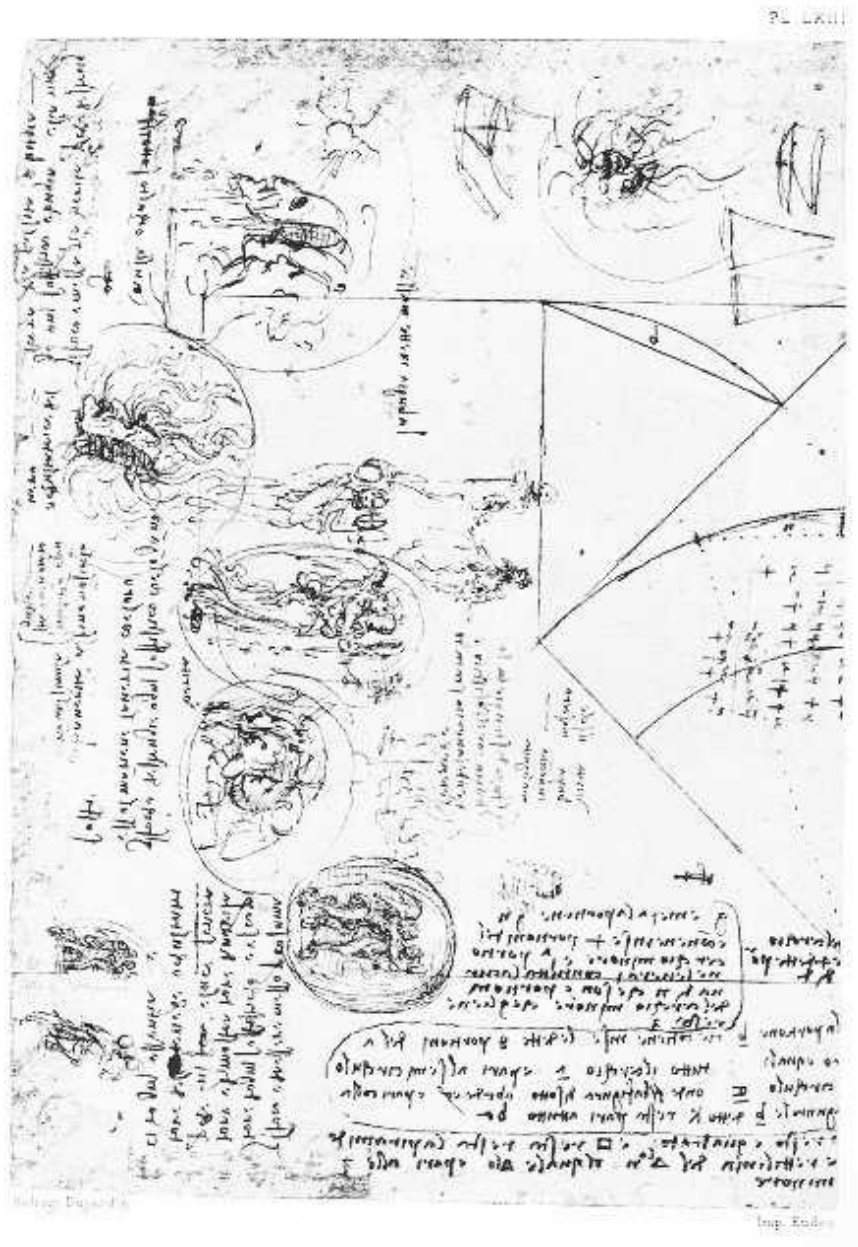


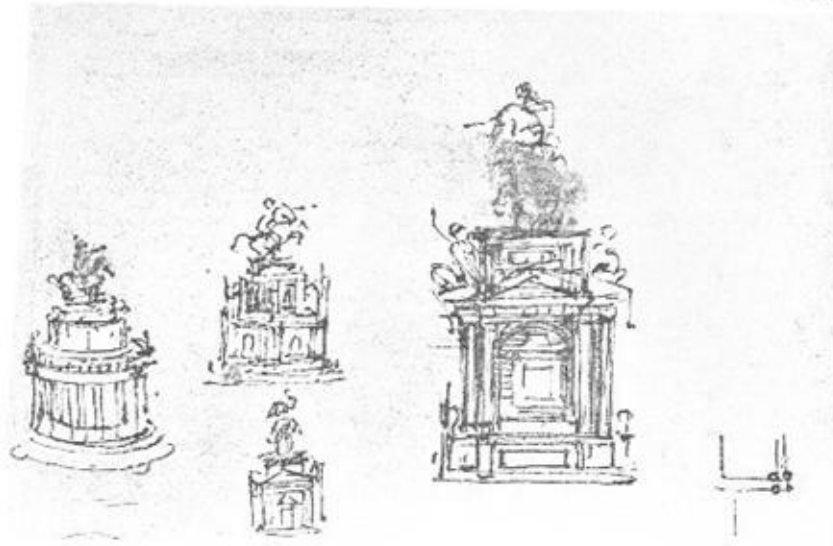
PLATE LXIV



H. J. Dujardin

Imp. Kuda

PLATE LXV



View of the monument

View of the monument

PLATE LXVI



PLATE LXVII



PLATE LXVIII



W. H. Stanger

Opp. Index

PLATE LXIX



PLATE LXX



PLATE LXXI



PLATE LXXII



PI. LXXII



Ilustre D. Juan

Imp. Lutes

PLATE LXXIII



PLATE LXXIV

PL. LXXIV



Hollog: Dupardin.

Imp. Eudes.

PLATE LXXV

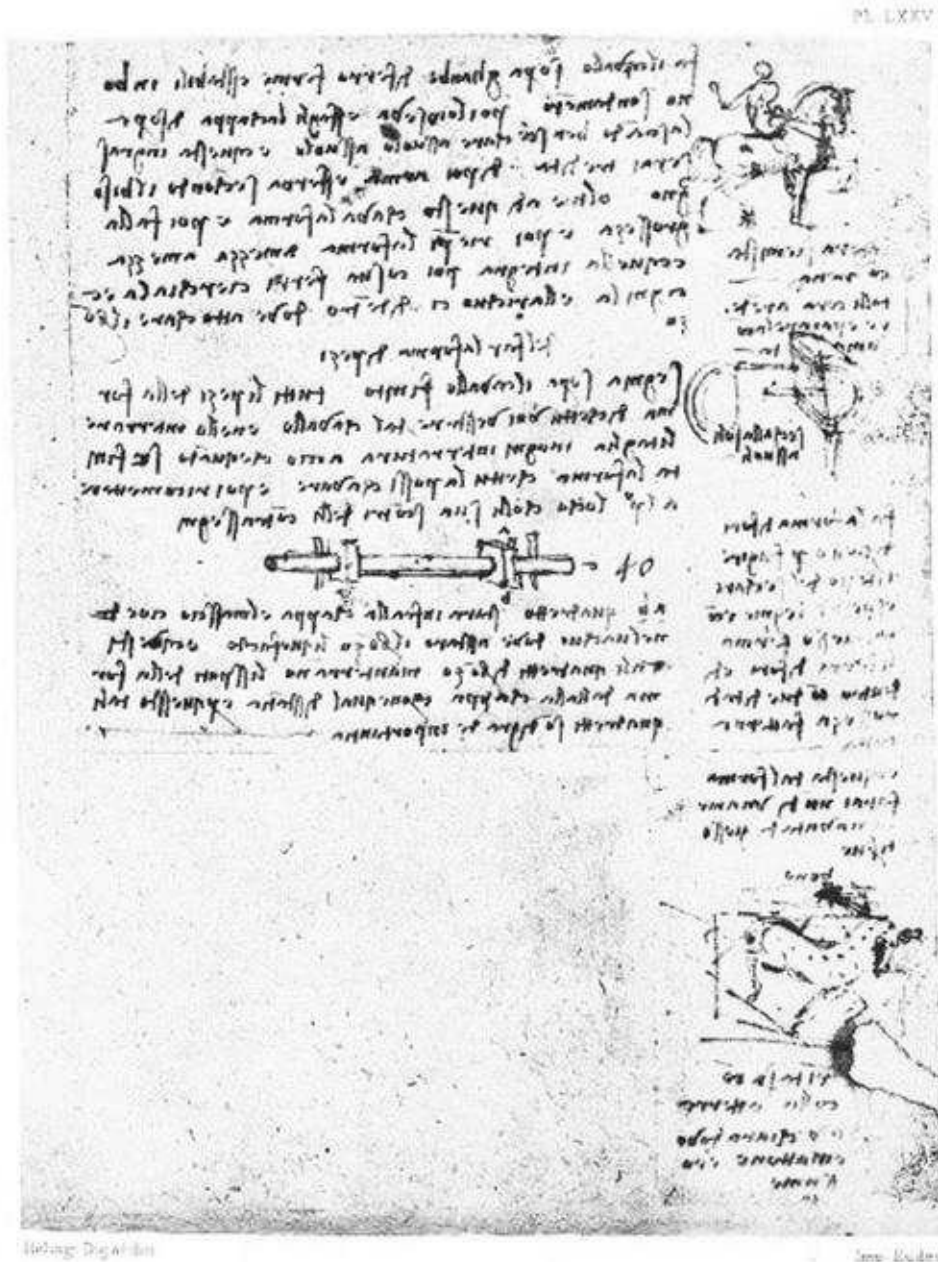
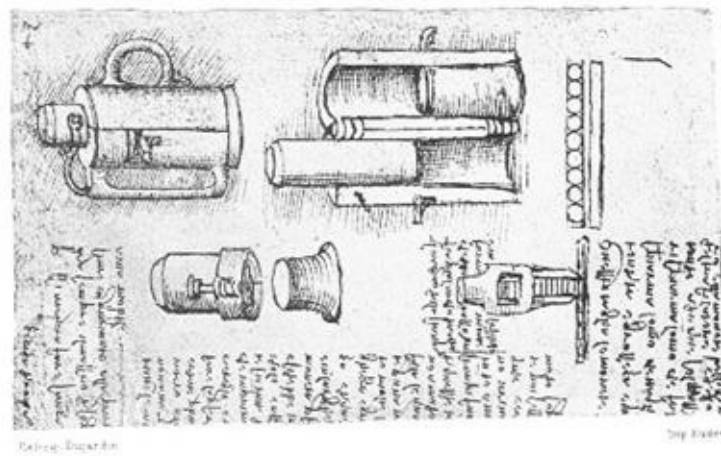
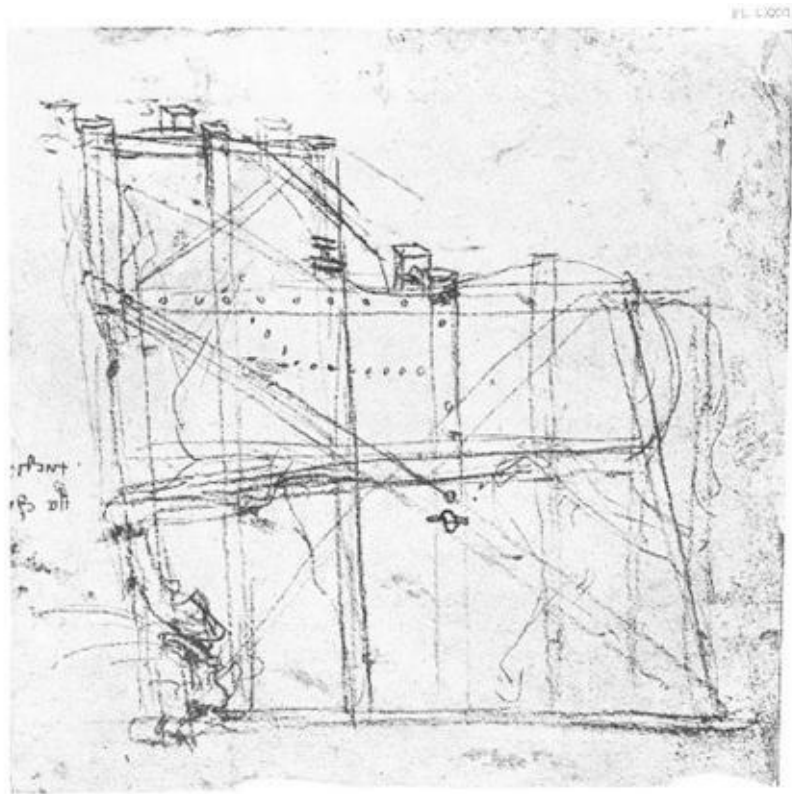


PLATE LXXVI



Del. E. B. G. R.

Top View

PLATE LXXVII

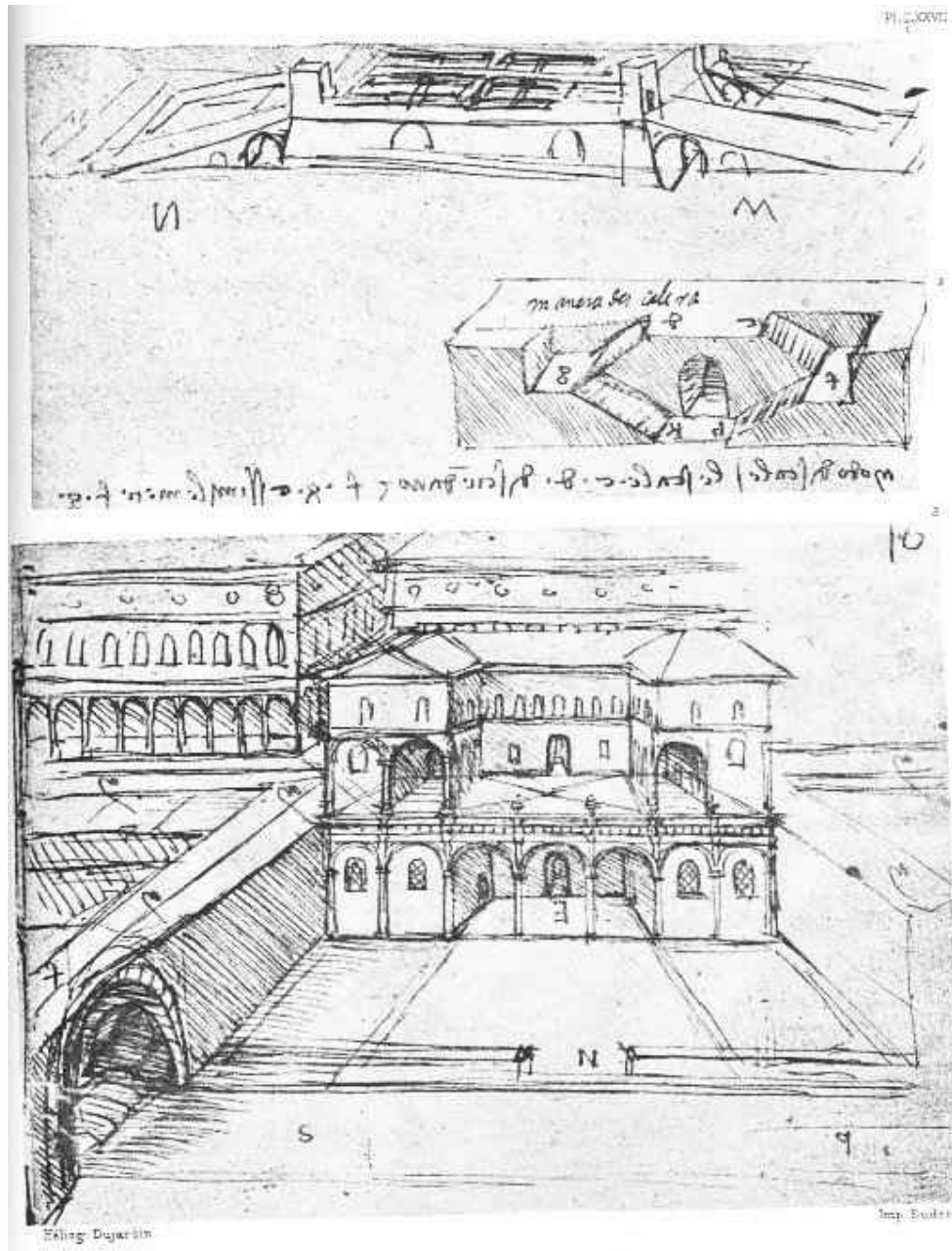


PLATE LXXVIII

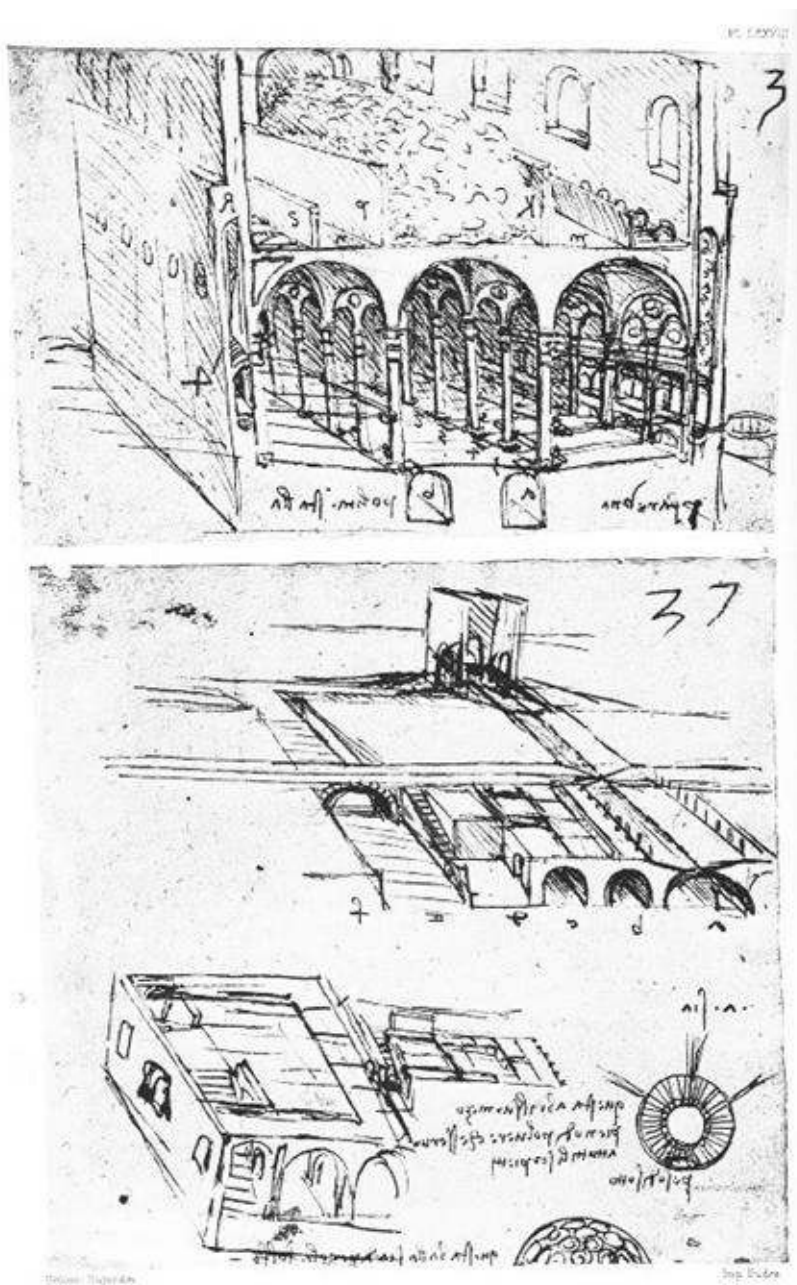
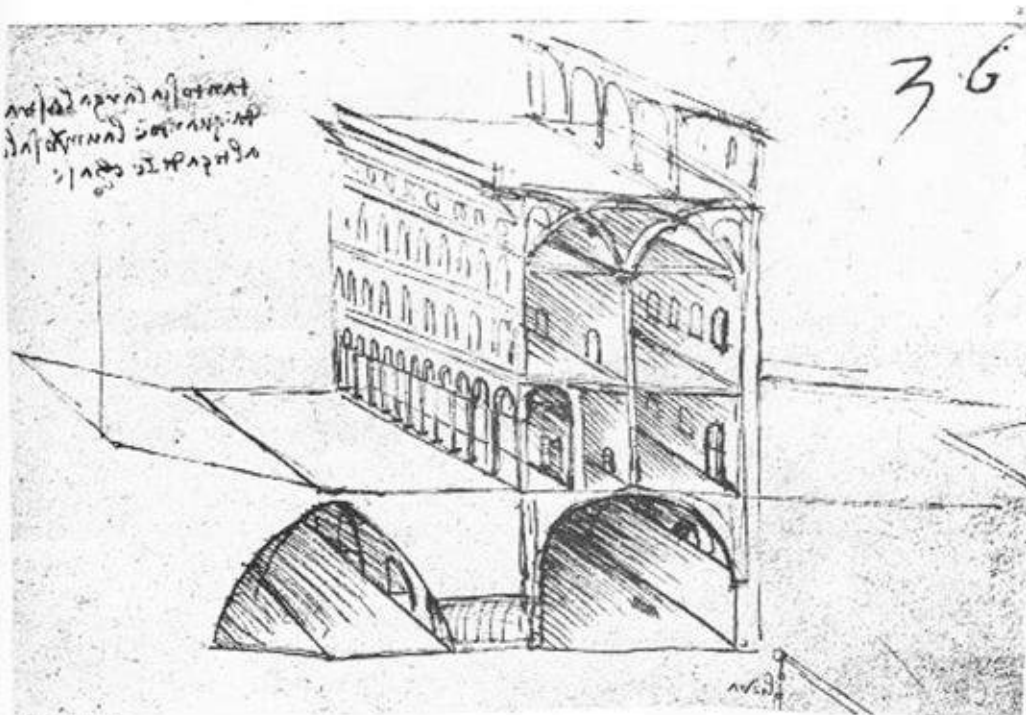
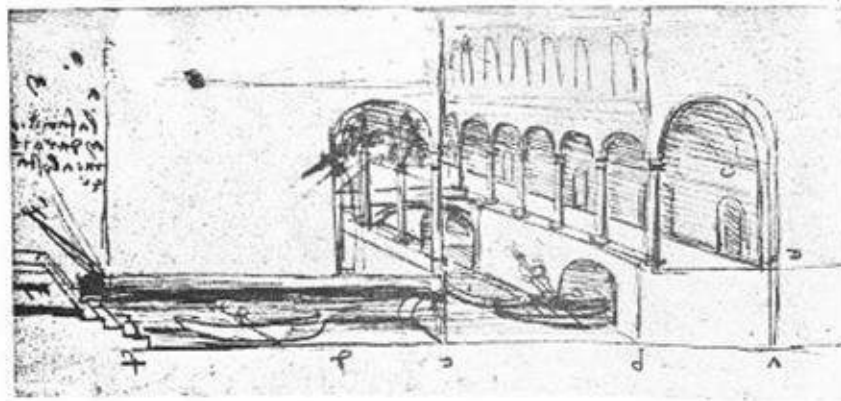


PLATE LXXIX



Belvedere

San Ludo

PLATE LXXX

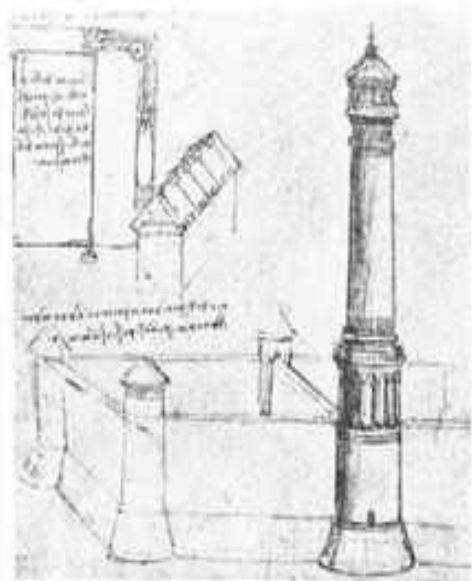
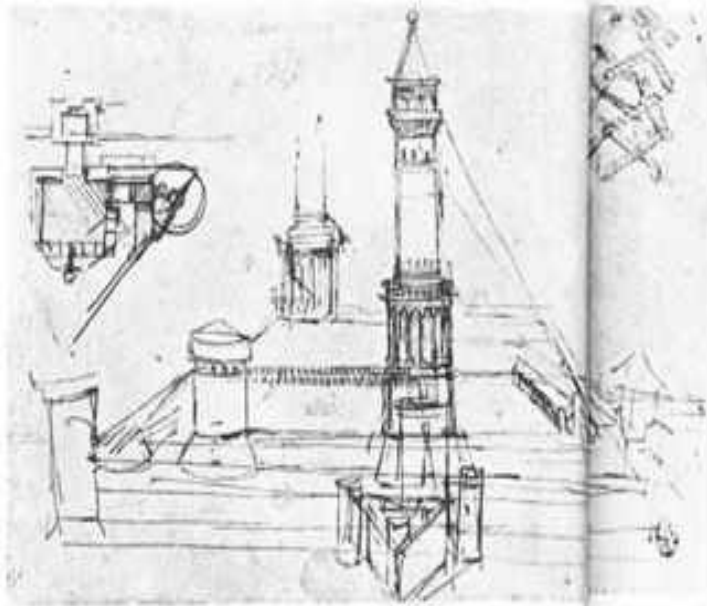


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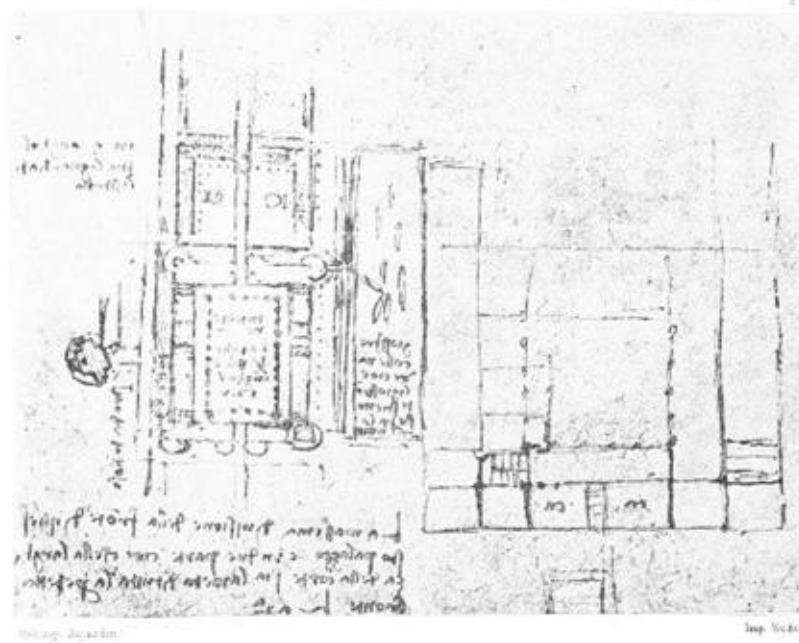
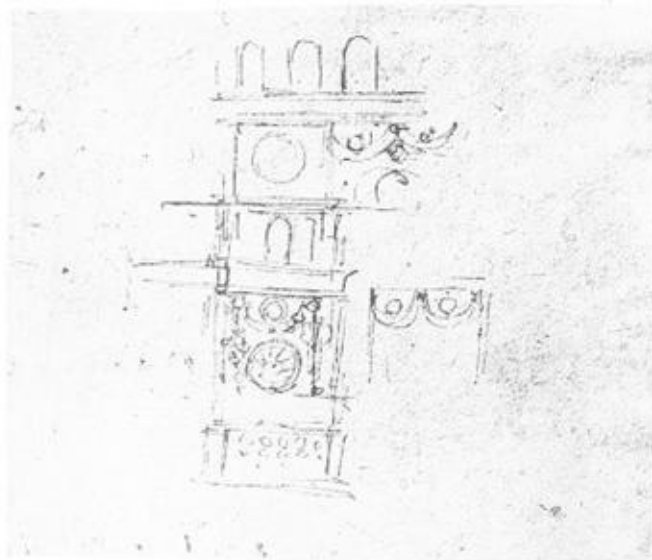


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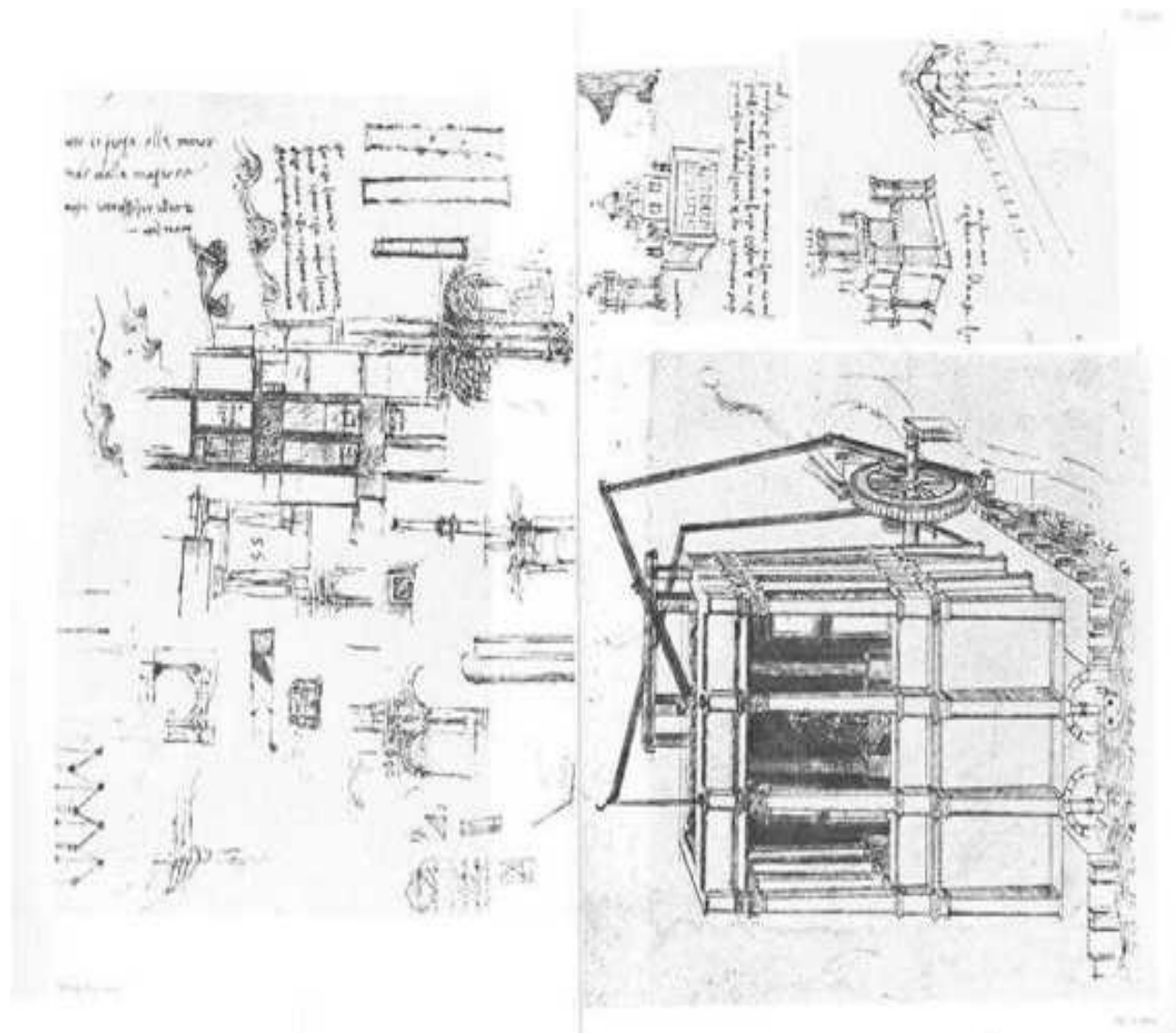


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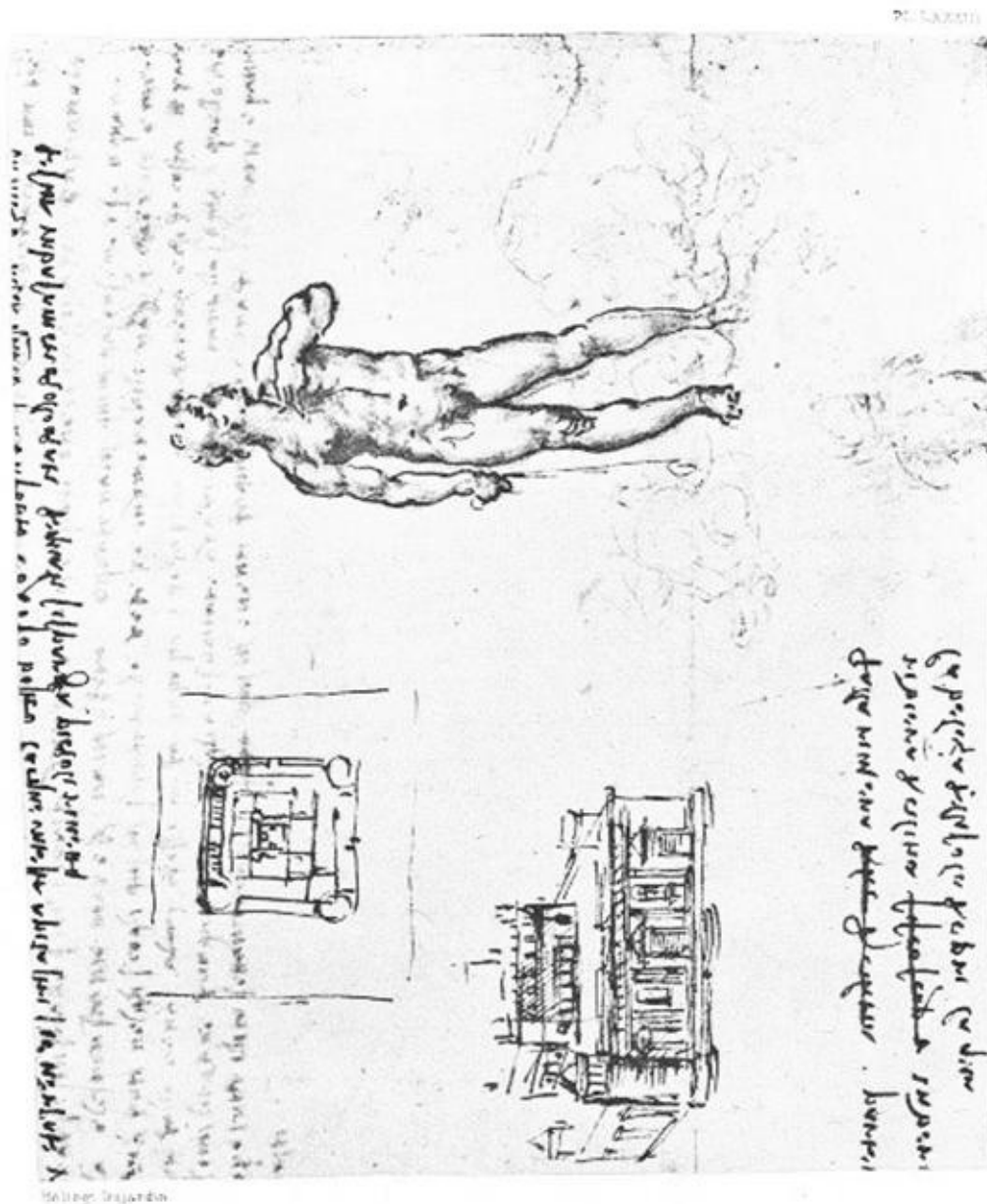


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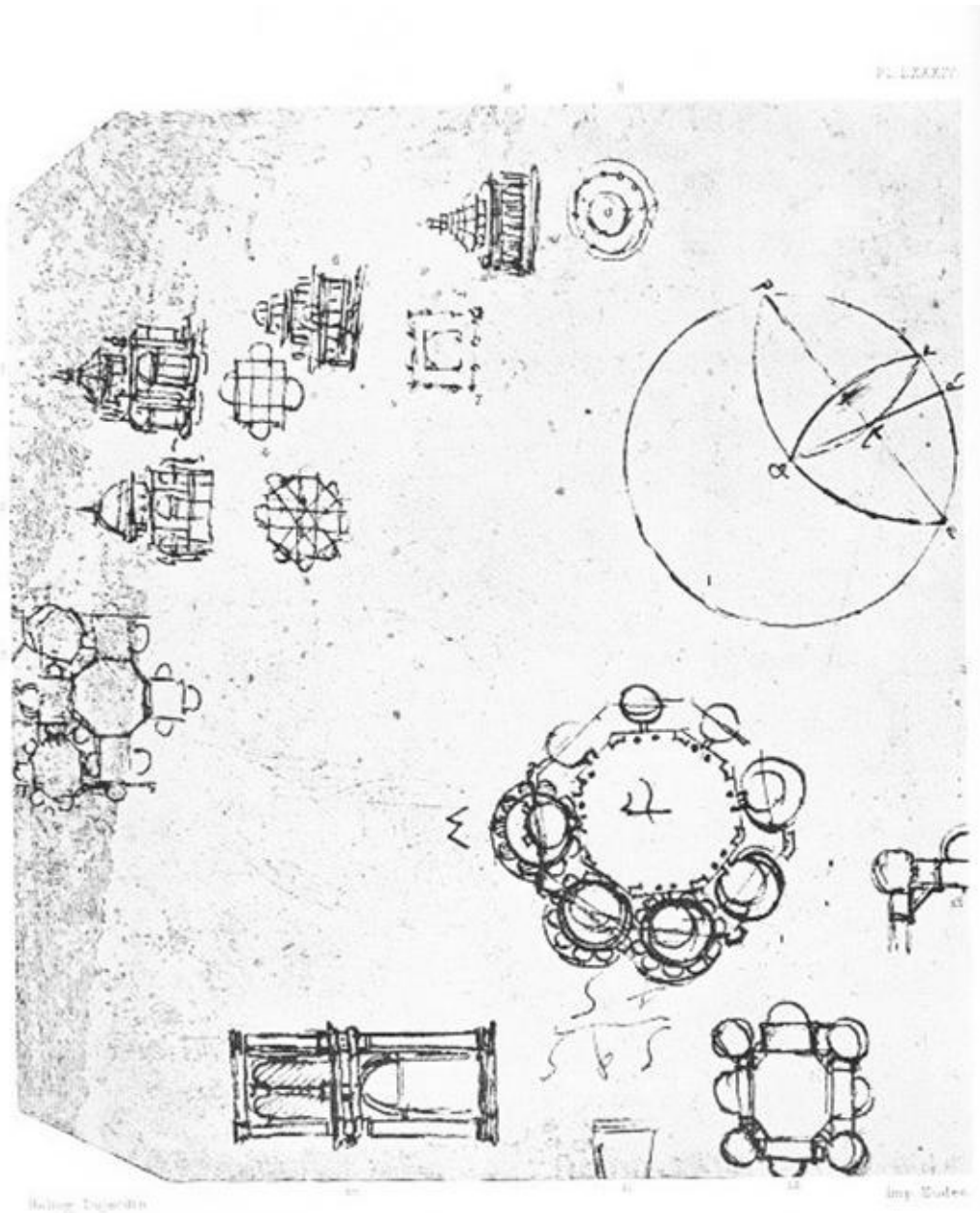
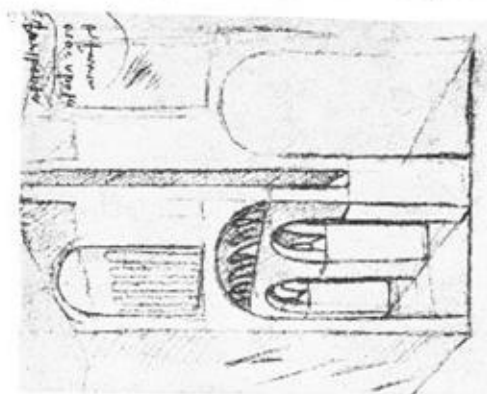
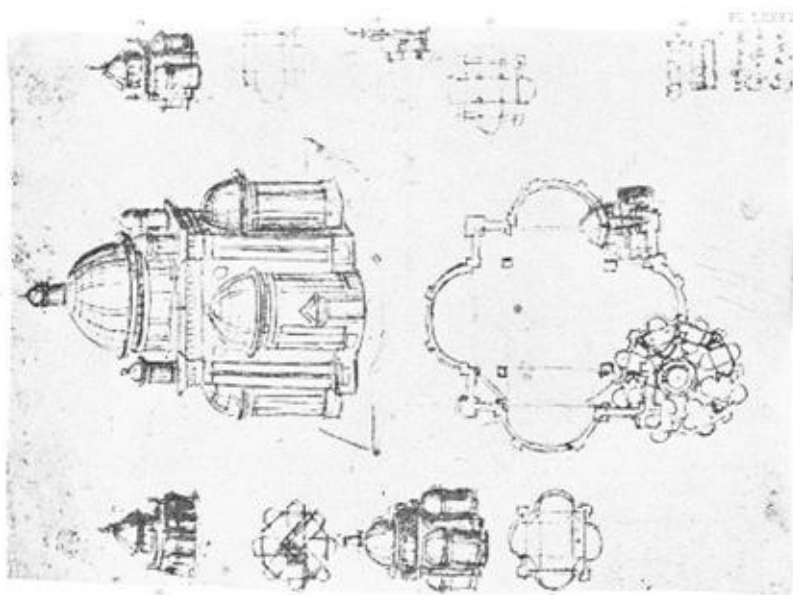


PLATE LXXXV



Deloer Lejardin



Deloer Lejardin

PLATE LXXXVI

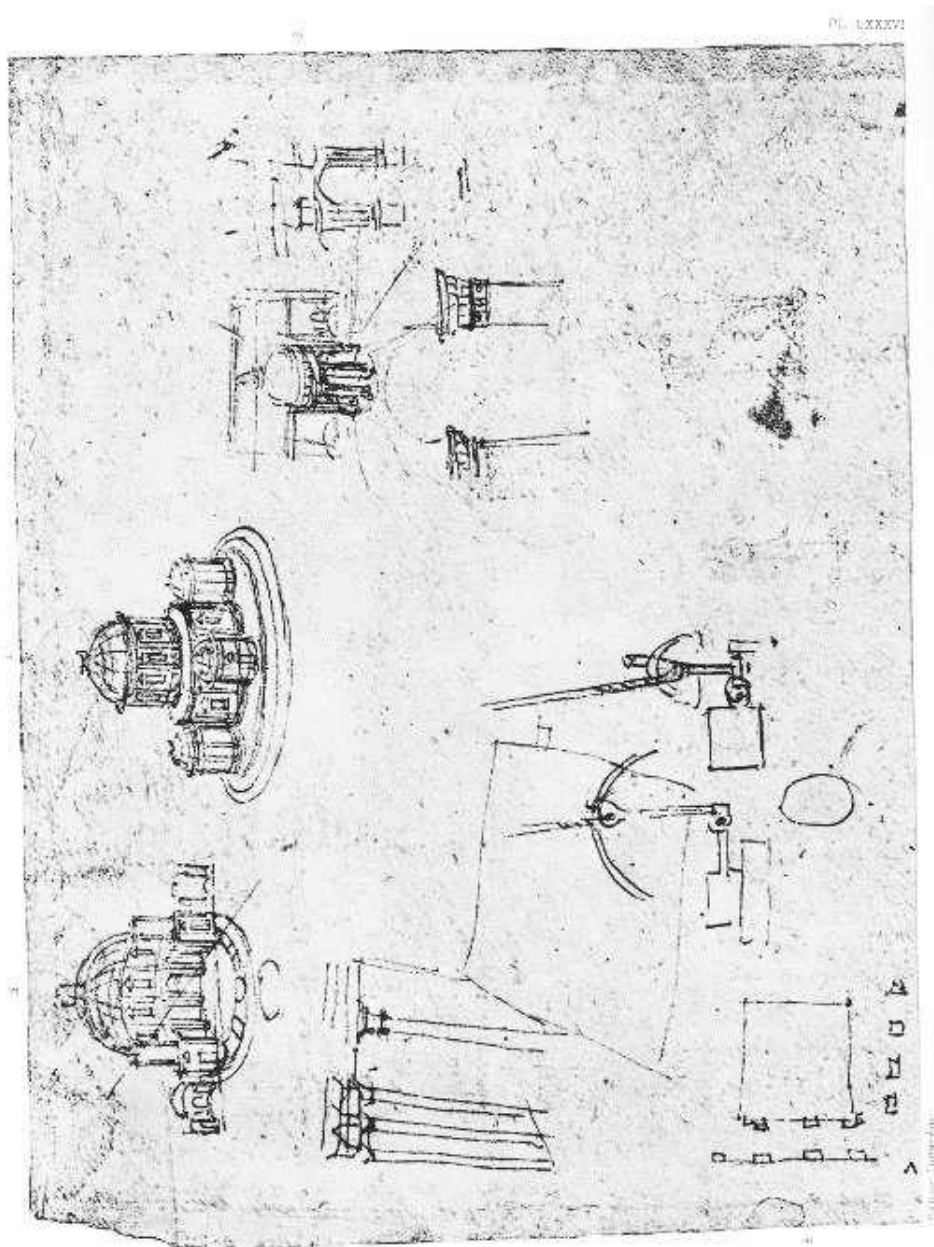


PLATE LXXXVII

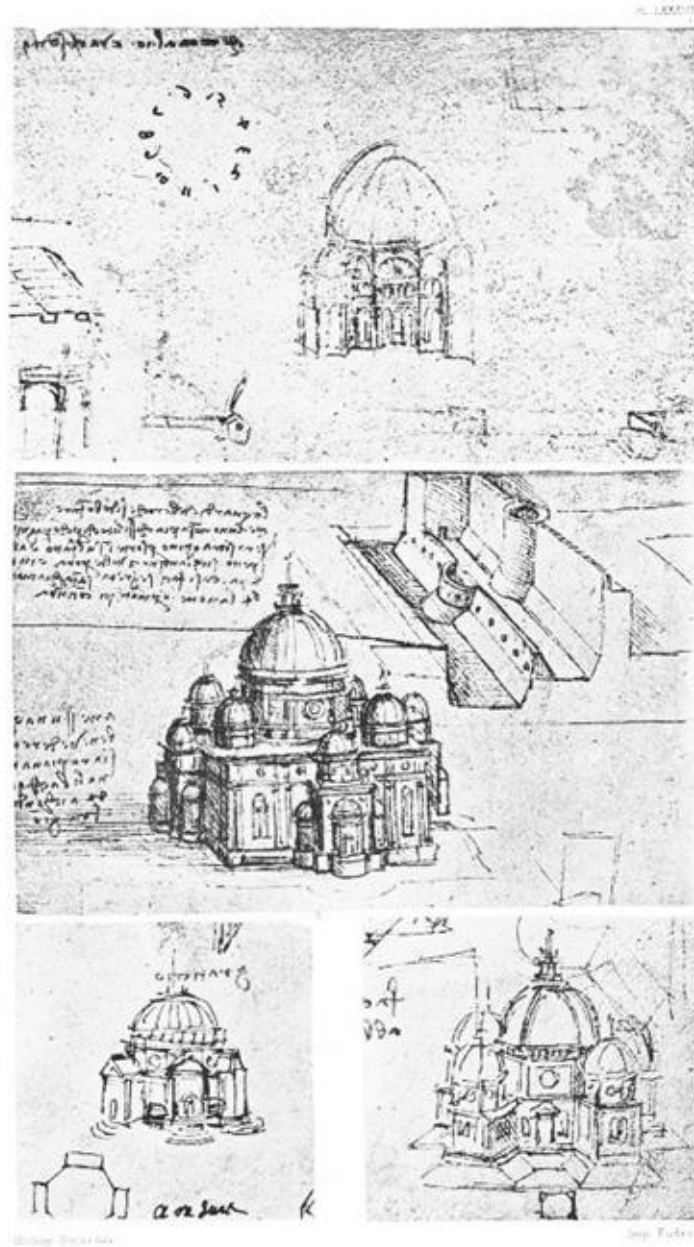


PLATE LXXXVIII

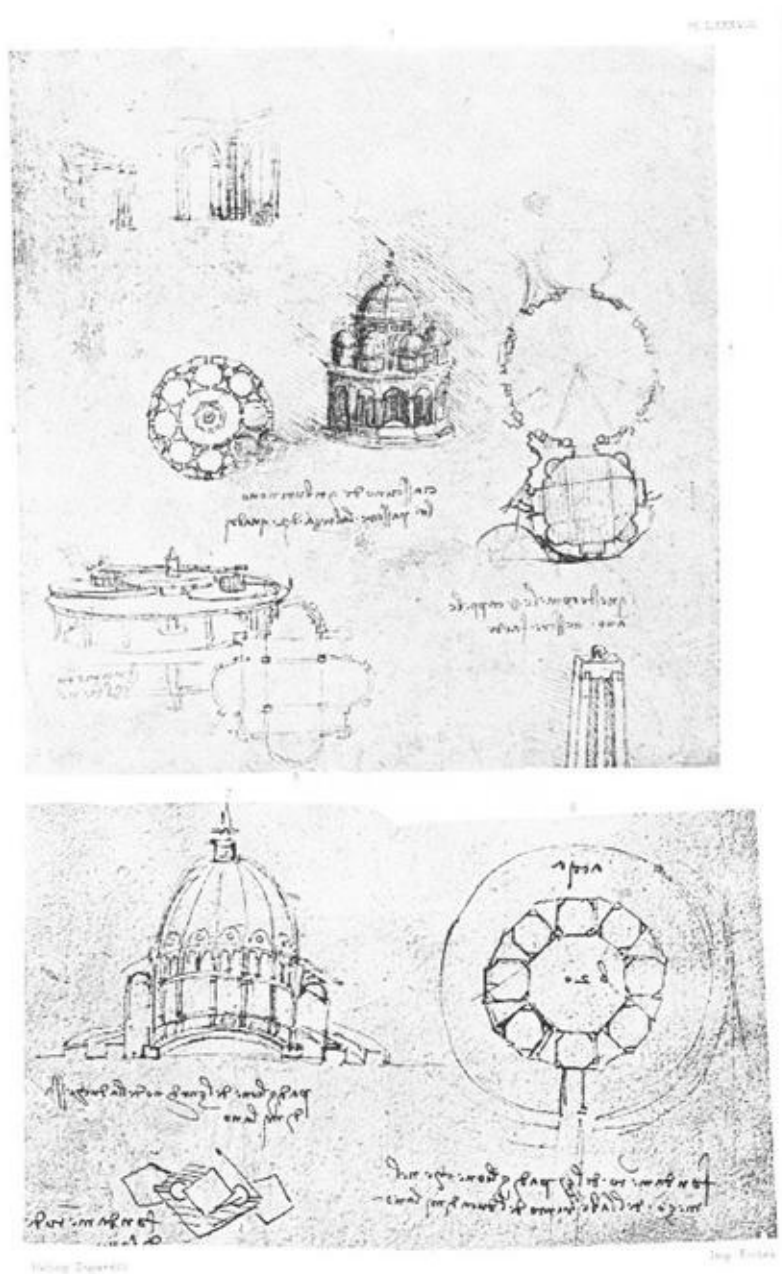
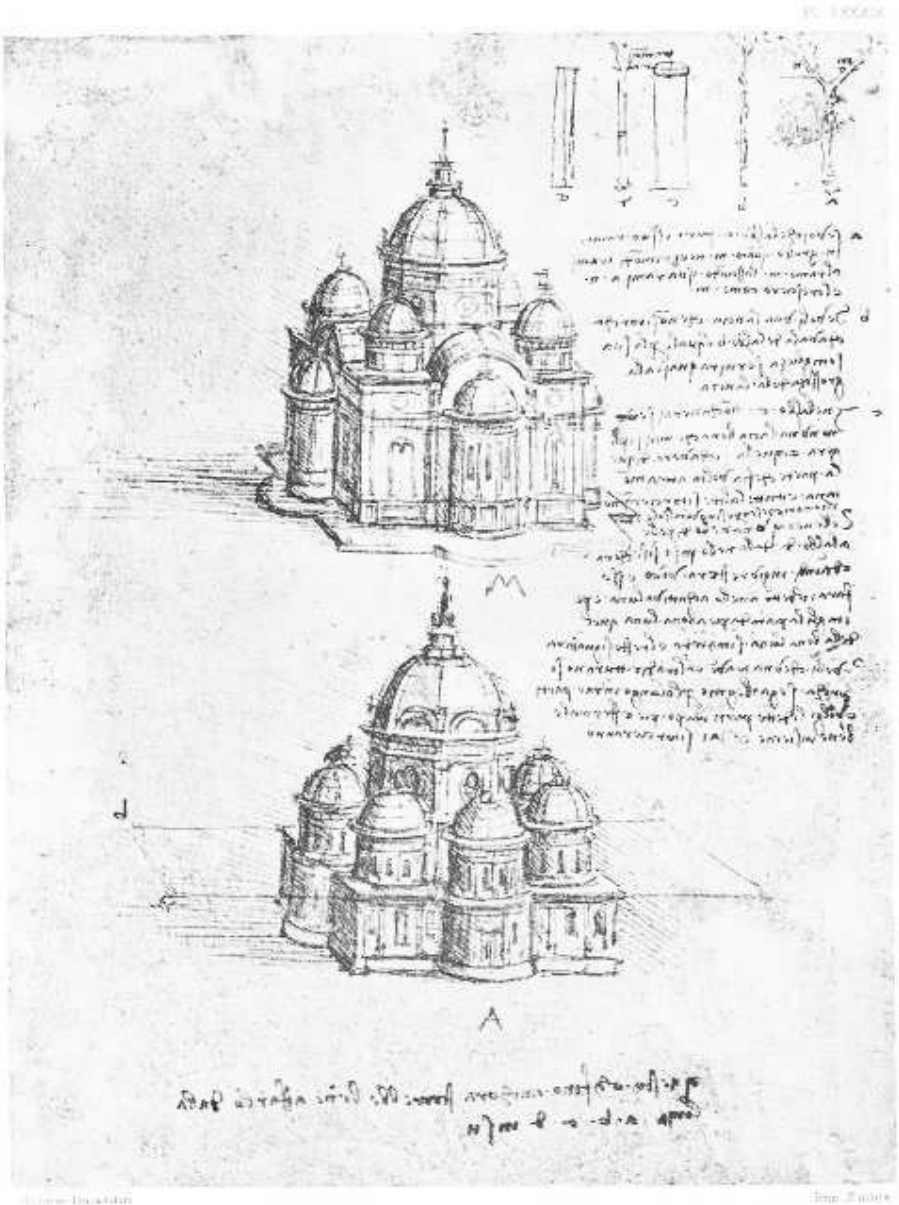


PLATE LXXXIX





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Volume 11 Number 1

PLATE XCI

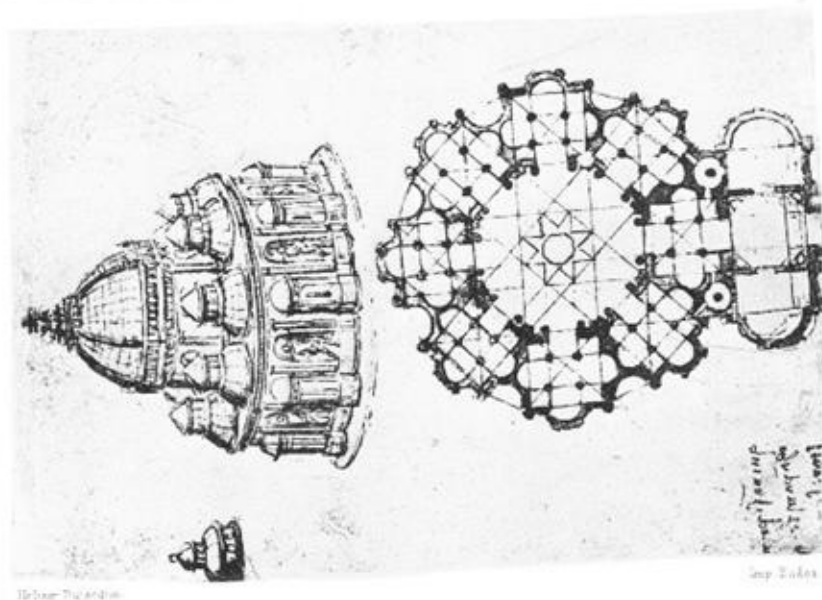
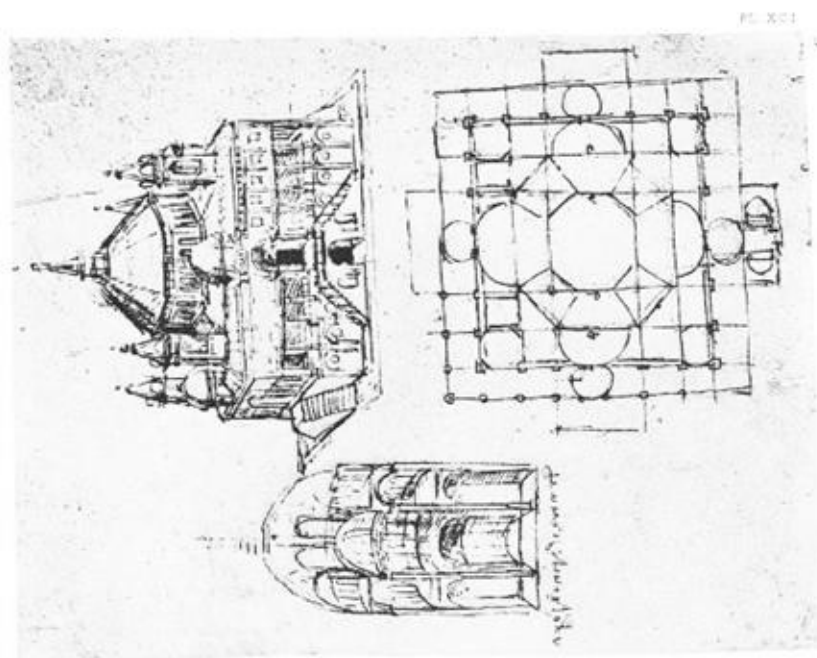
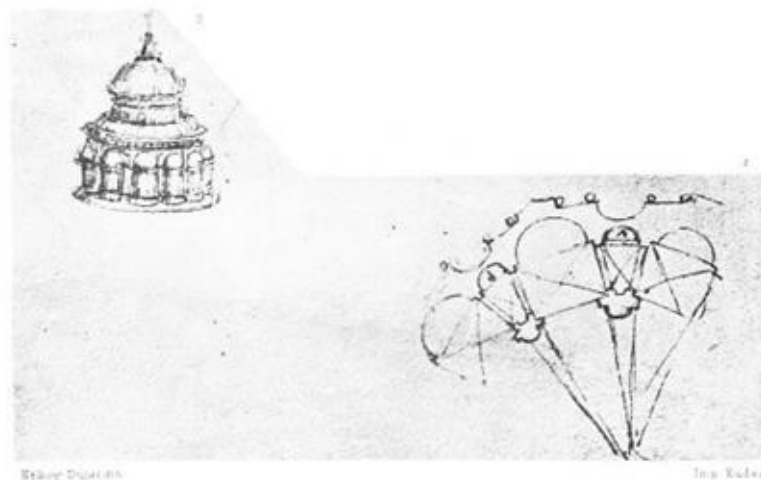
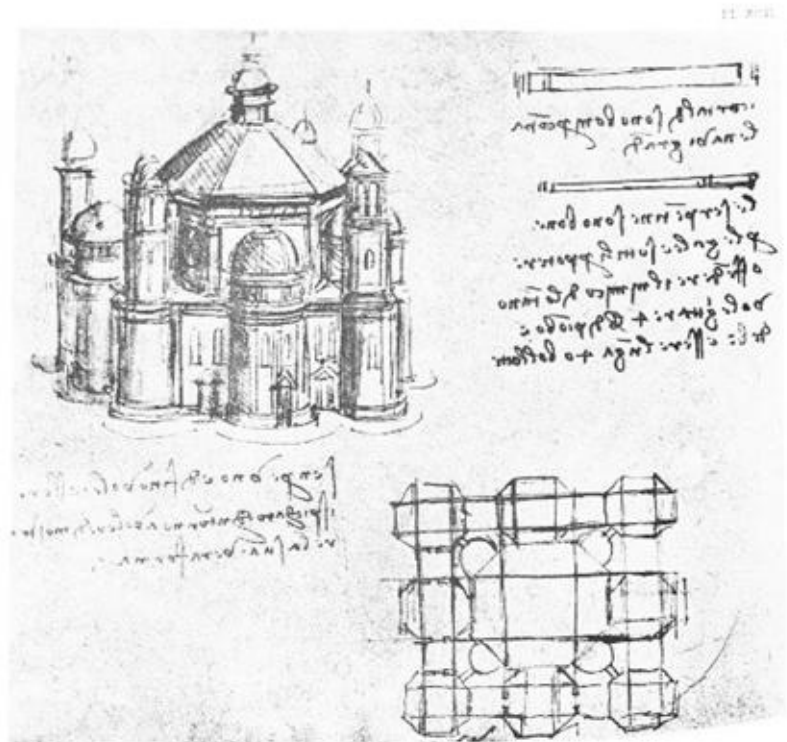
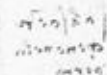


PLATE XCII



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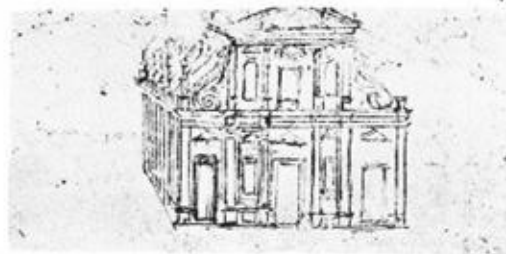
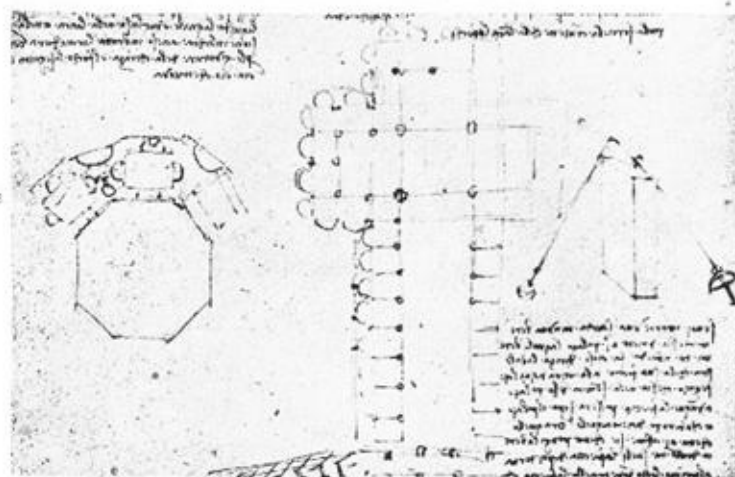
Imp. Kolar



Key Points

PLATE XCIV

PL. XCIV.



Holog. Duguet.

Imp. Dufour.

PLATE XCV

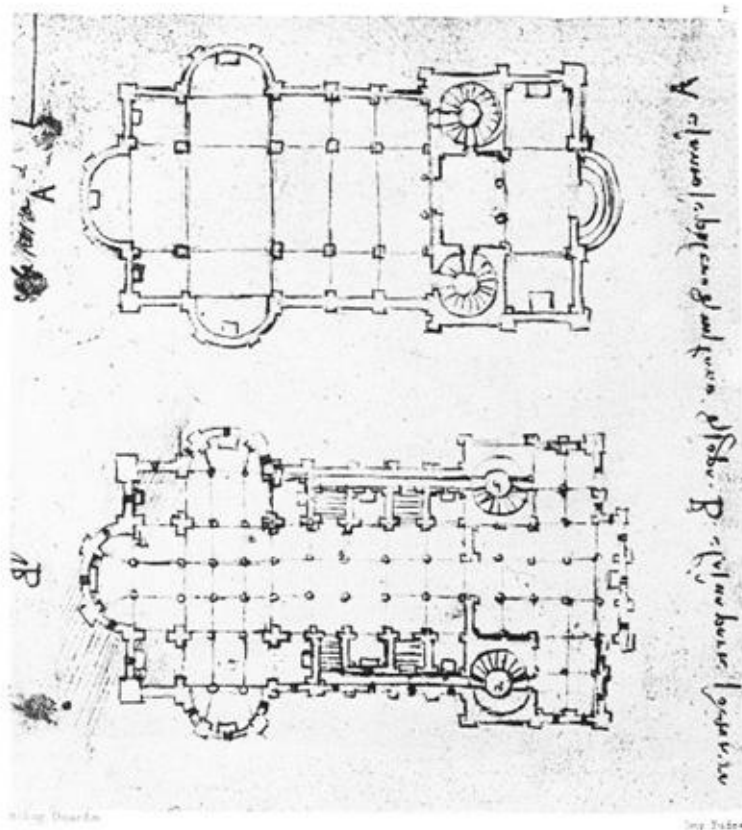
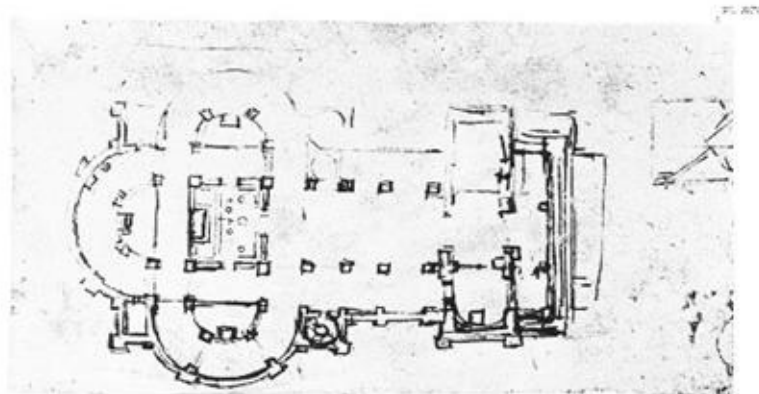


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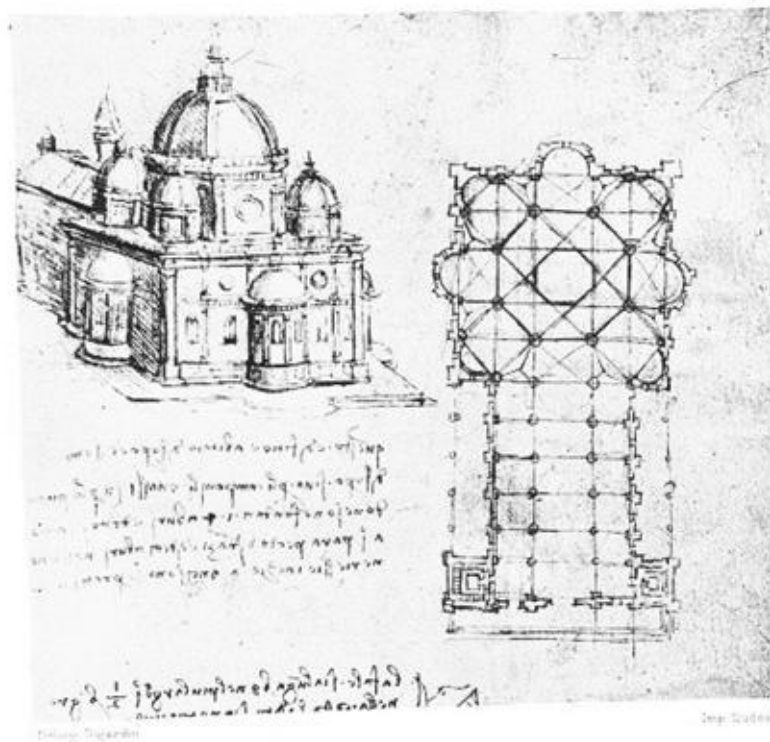
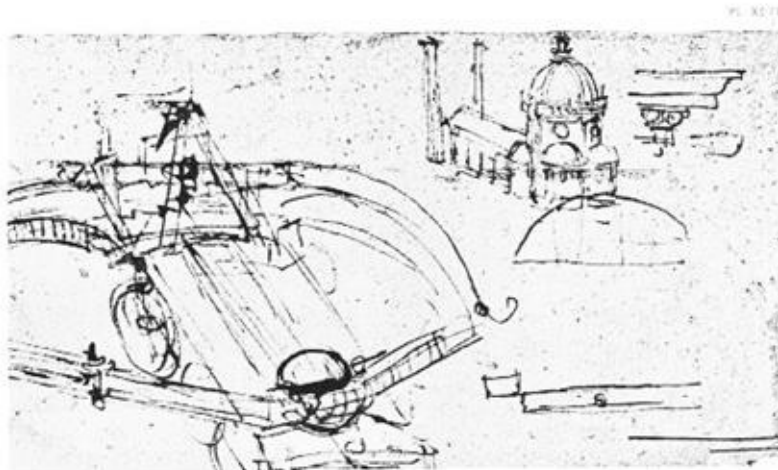


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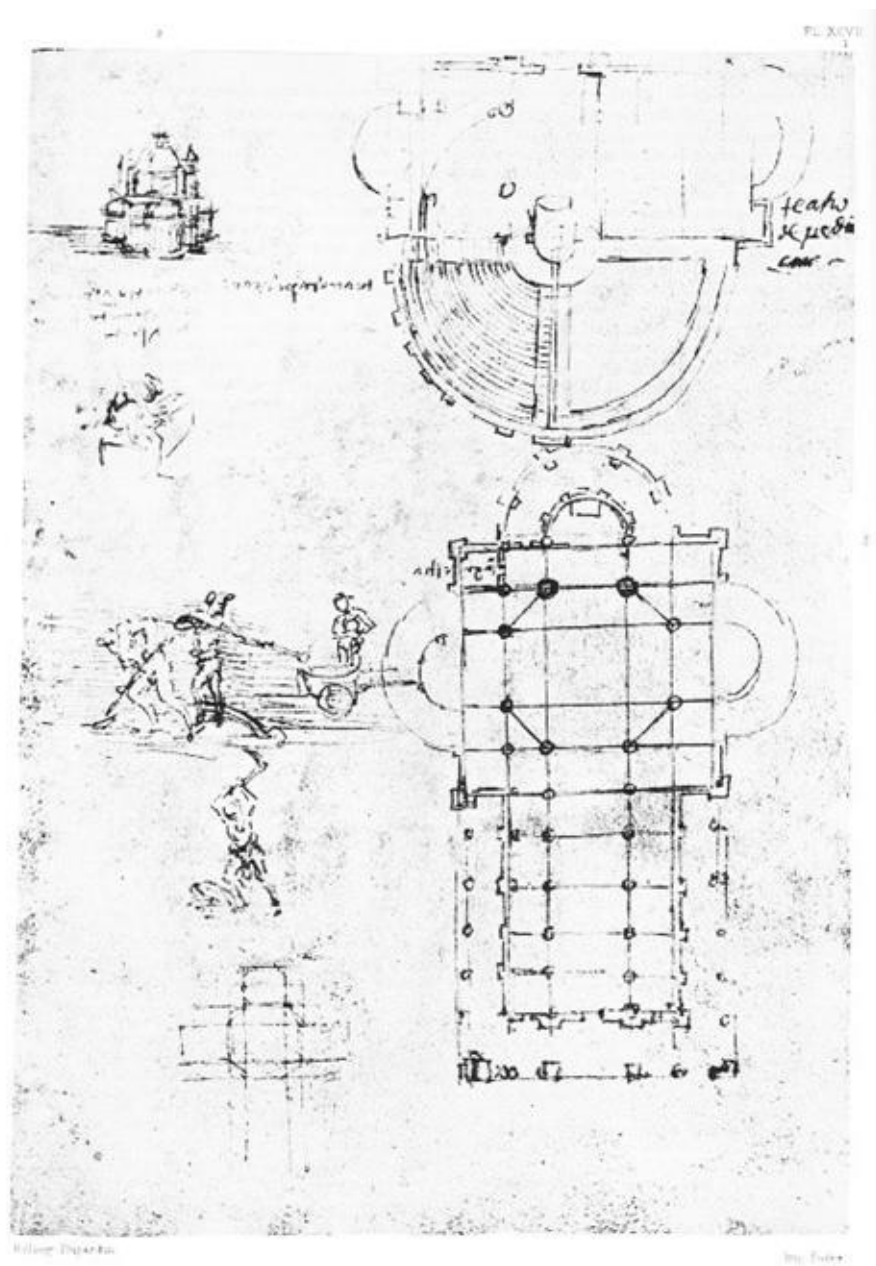


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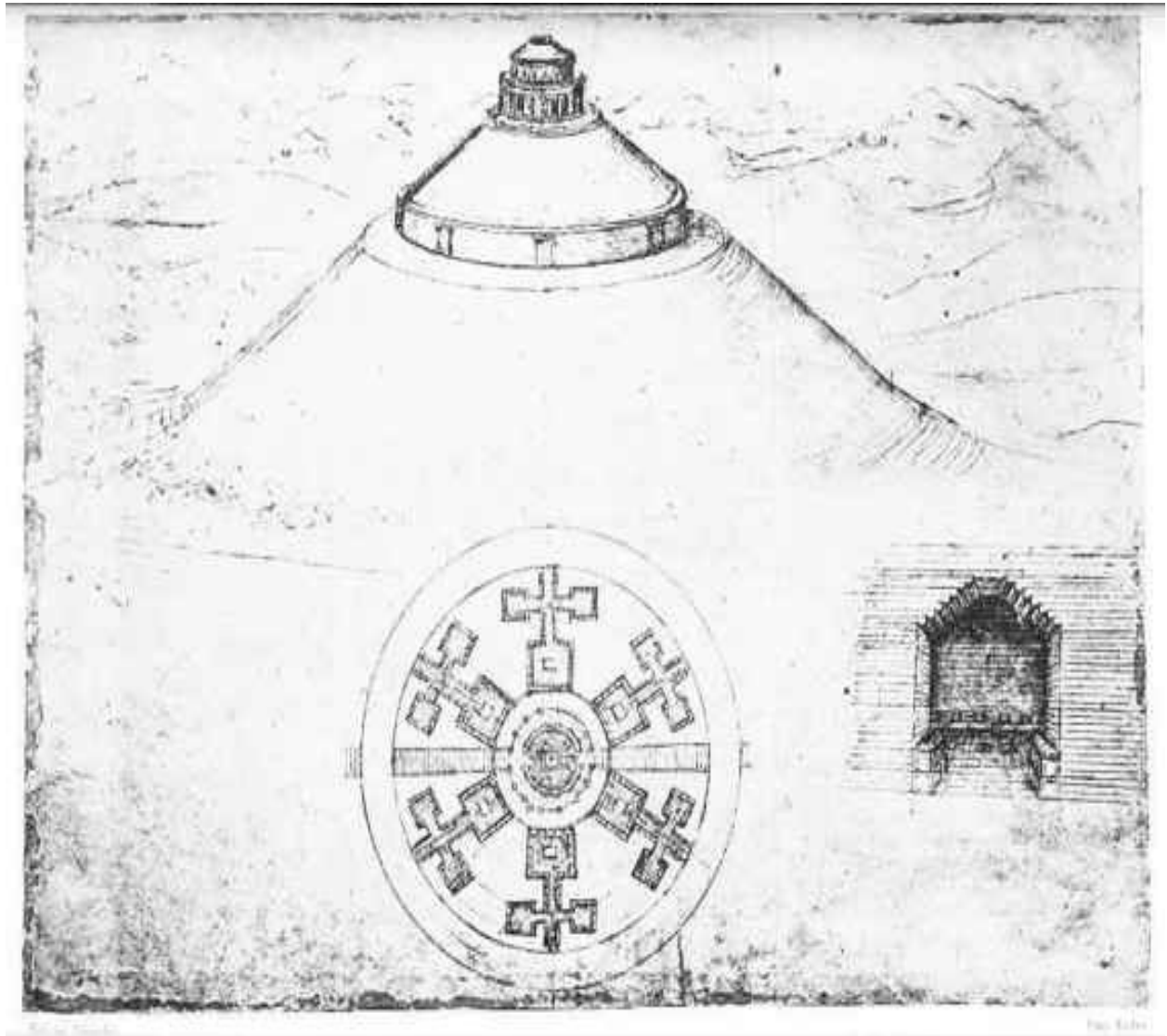


PLATE XCIX

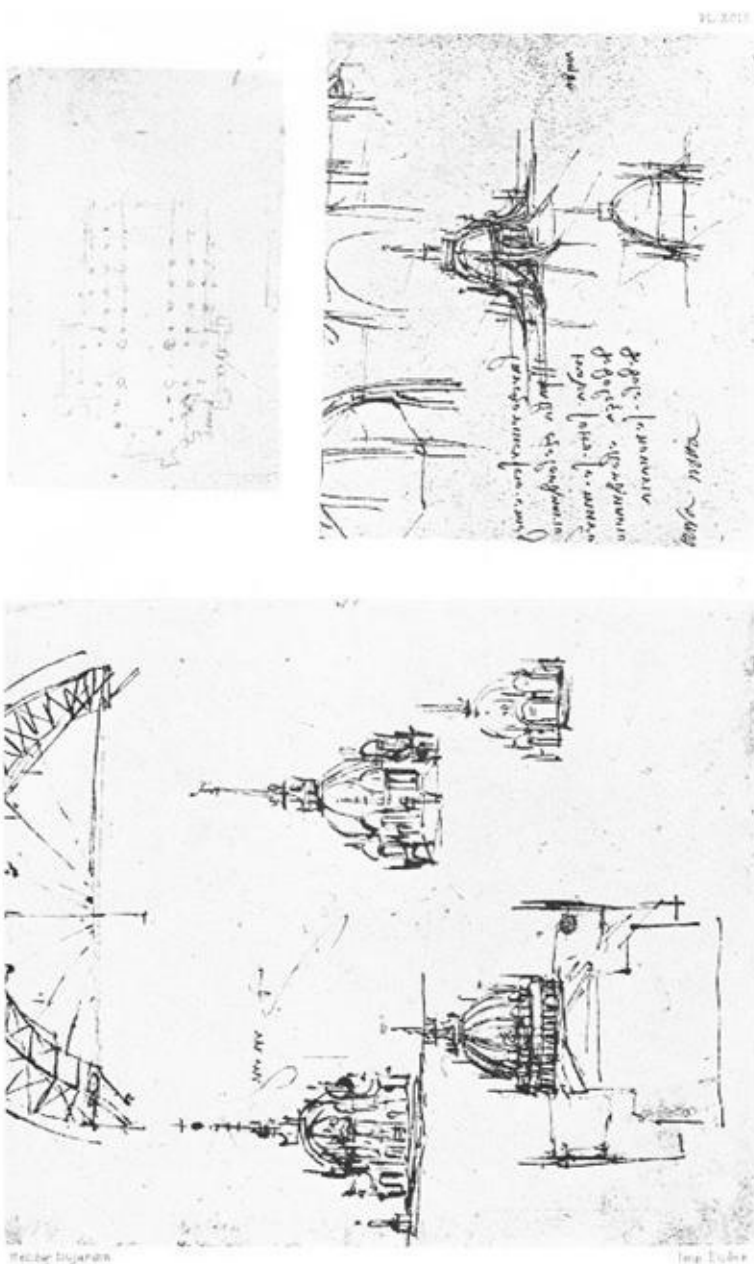


PLATE C

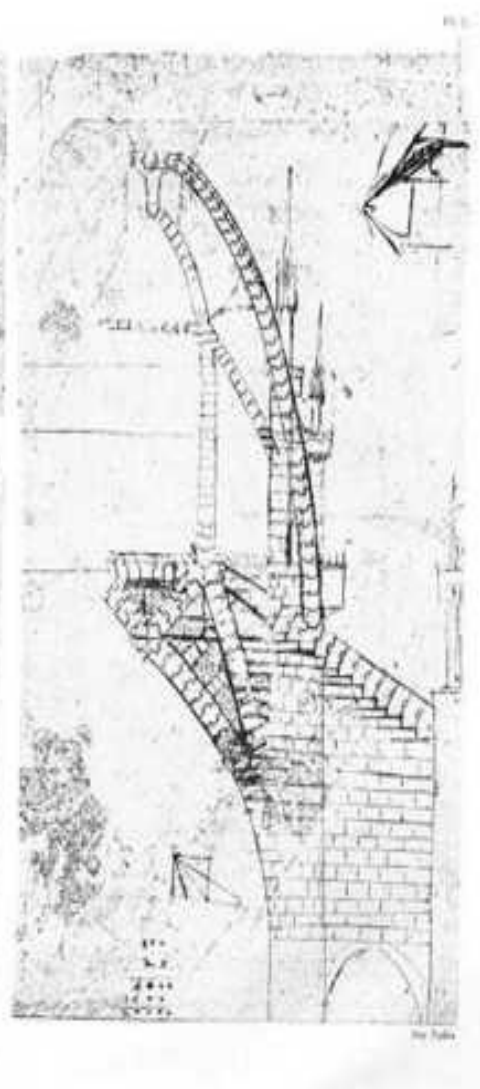
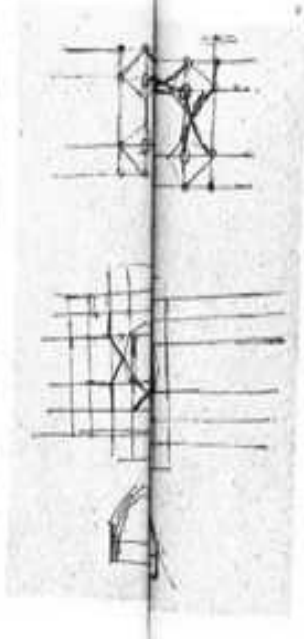
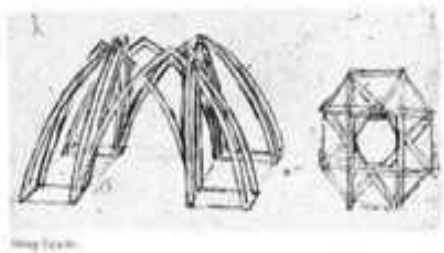
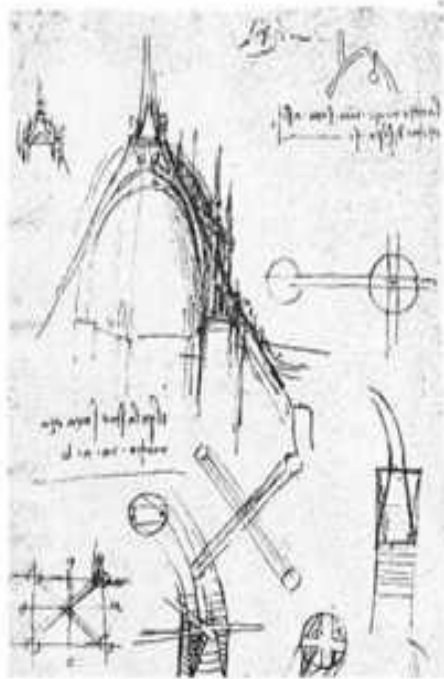


PLATE CI

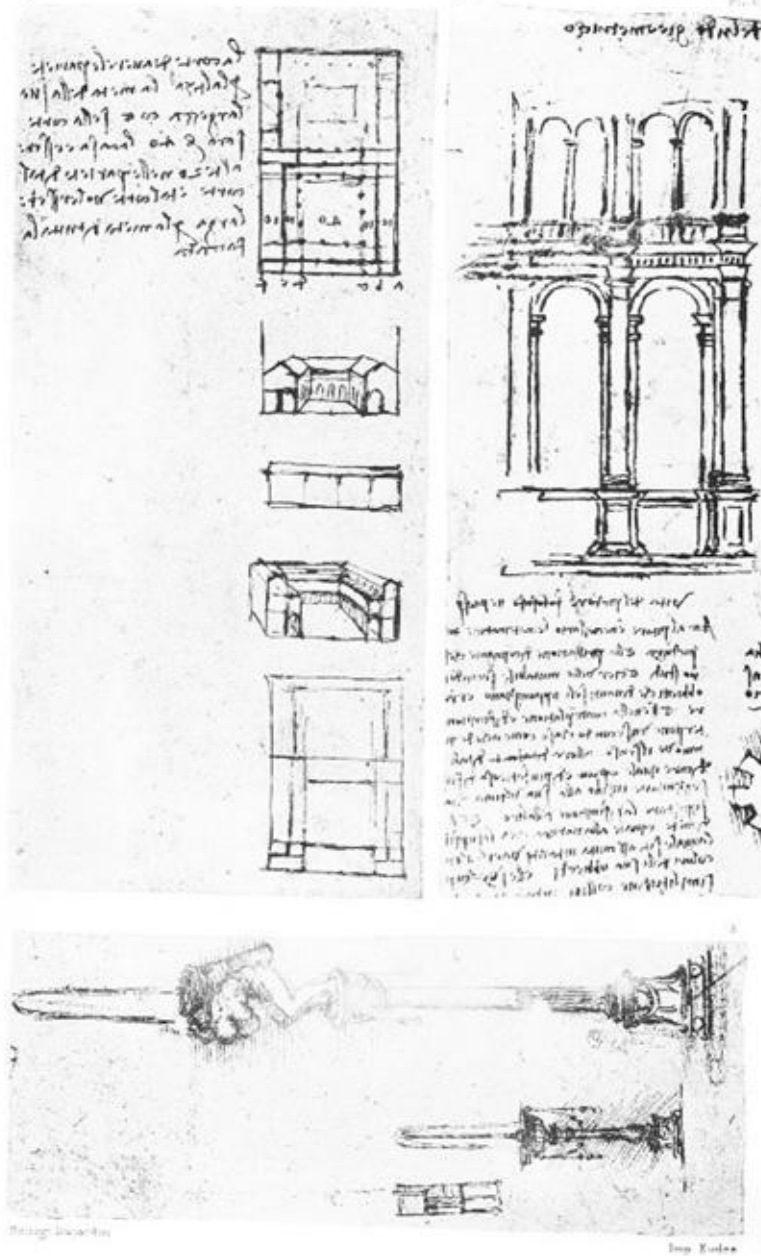


PLATE CII

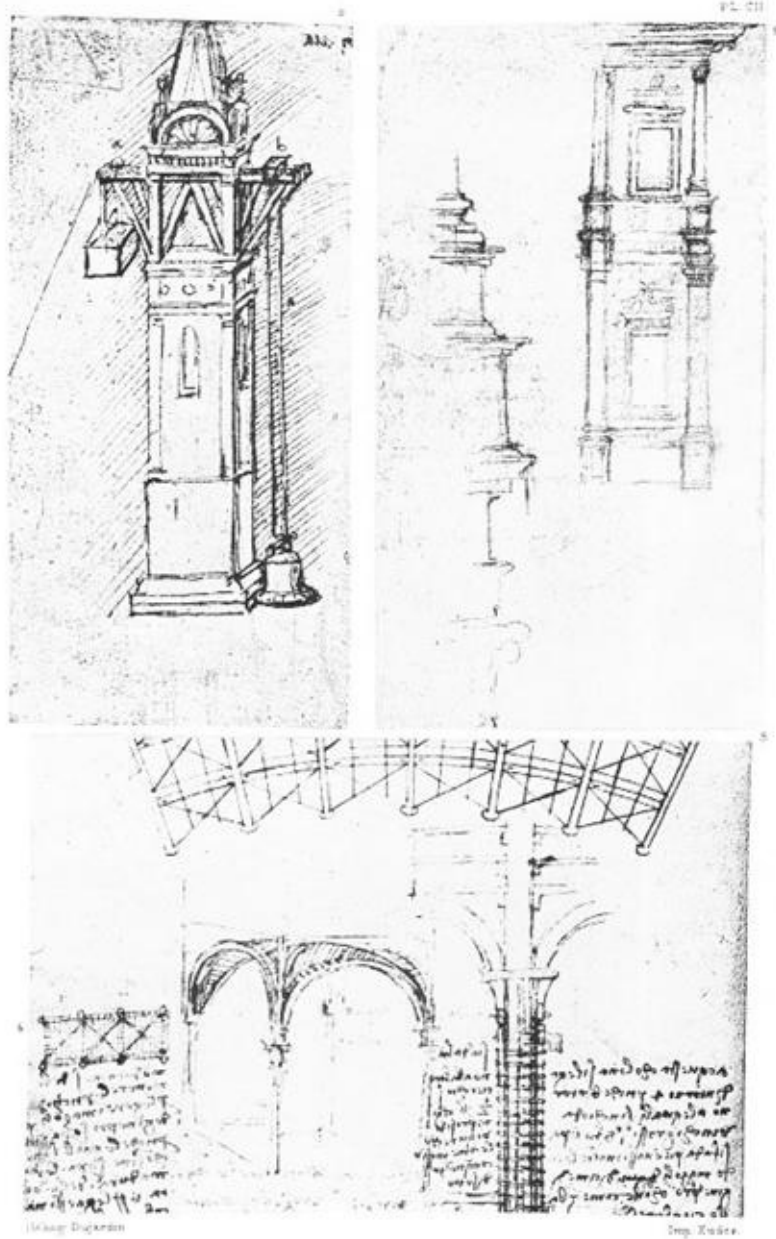


PLATE CIII

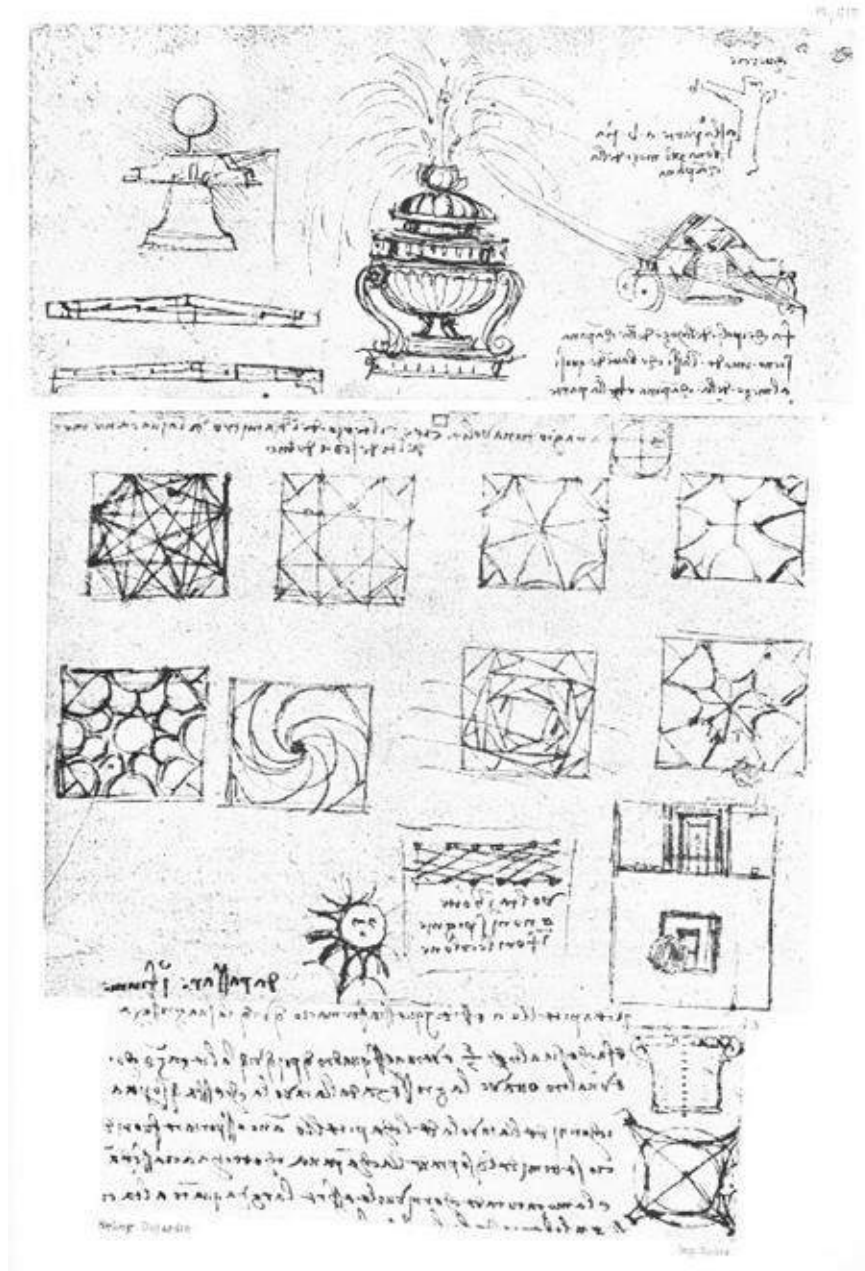


PLATE CIV



PLATE CV

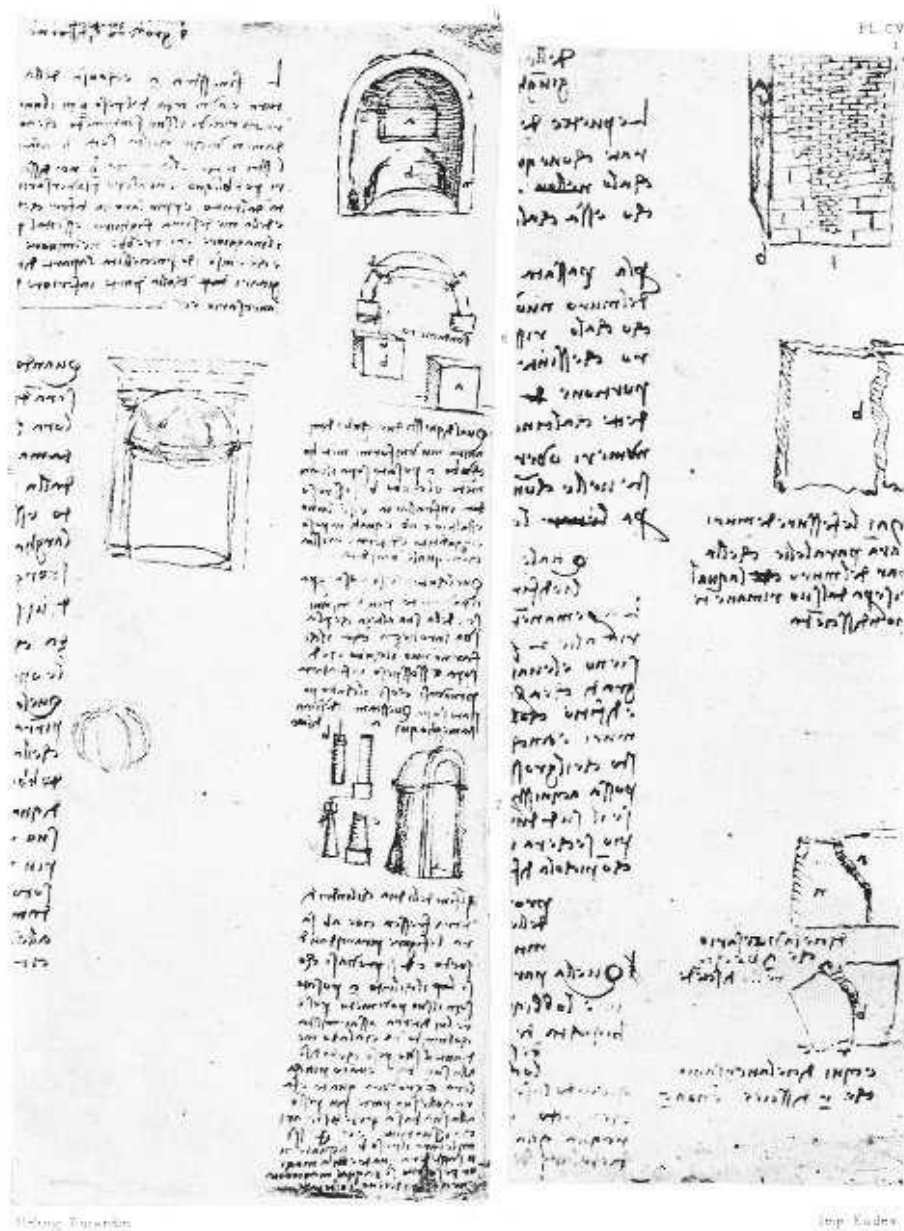


PLATE CVI



PLATE CVII



PLATE CVIII

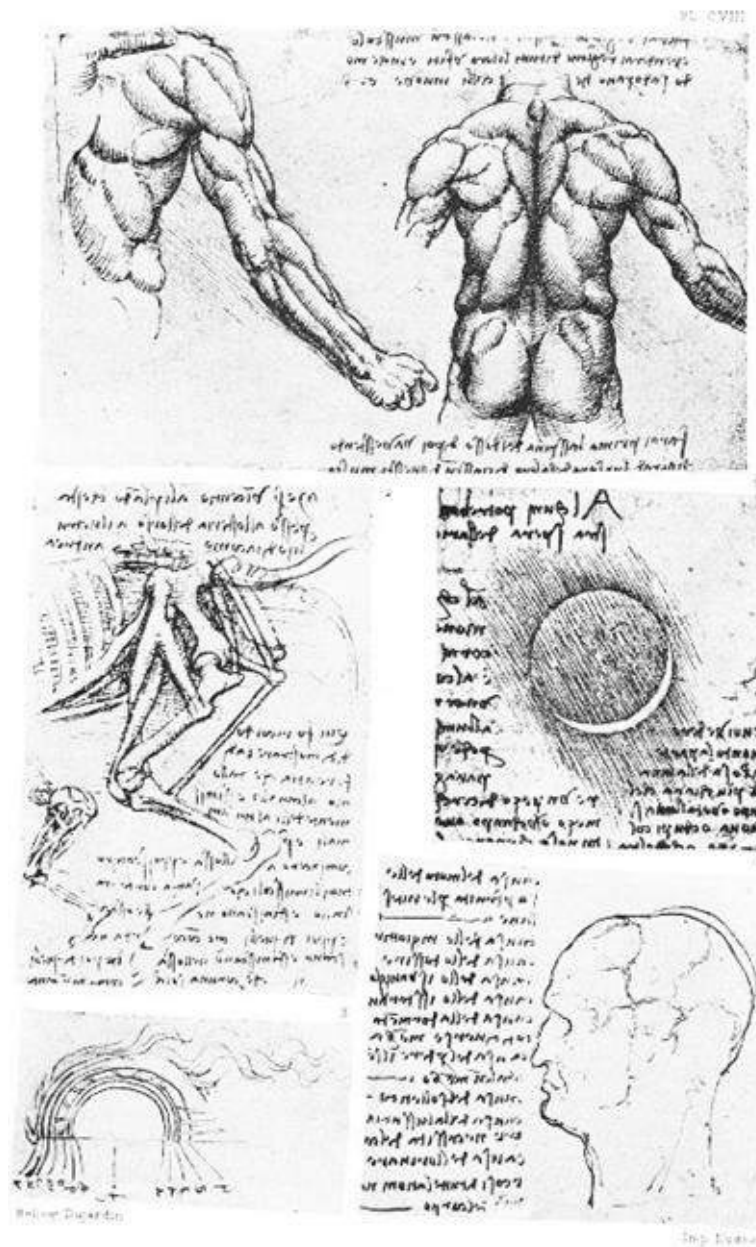


PLATE CIX

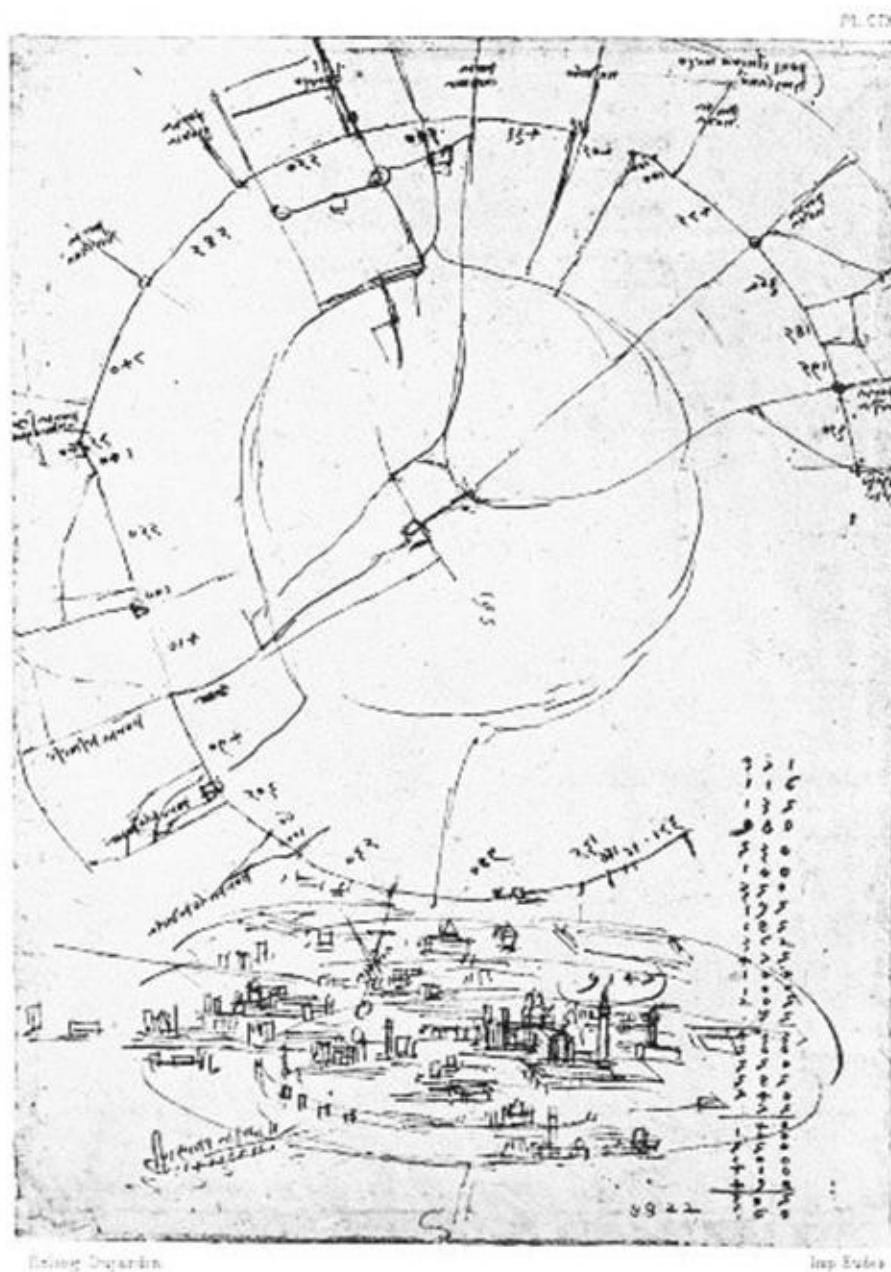


PLATE CX

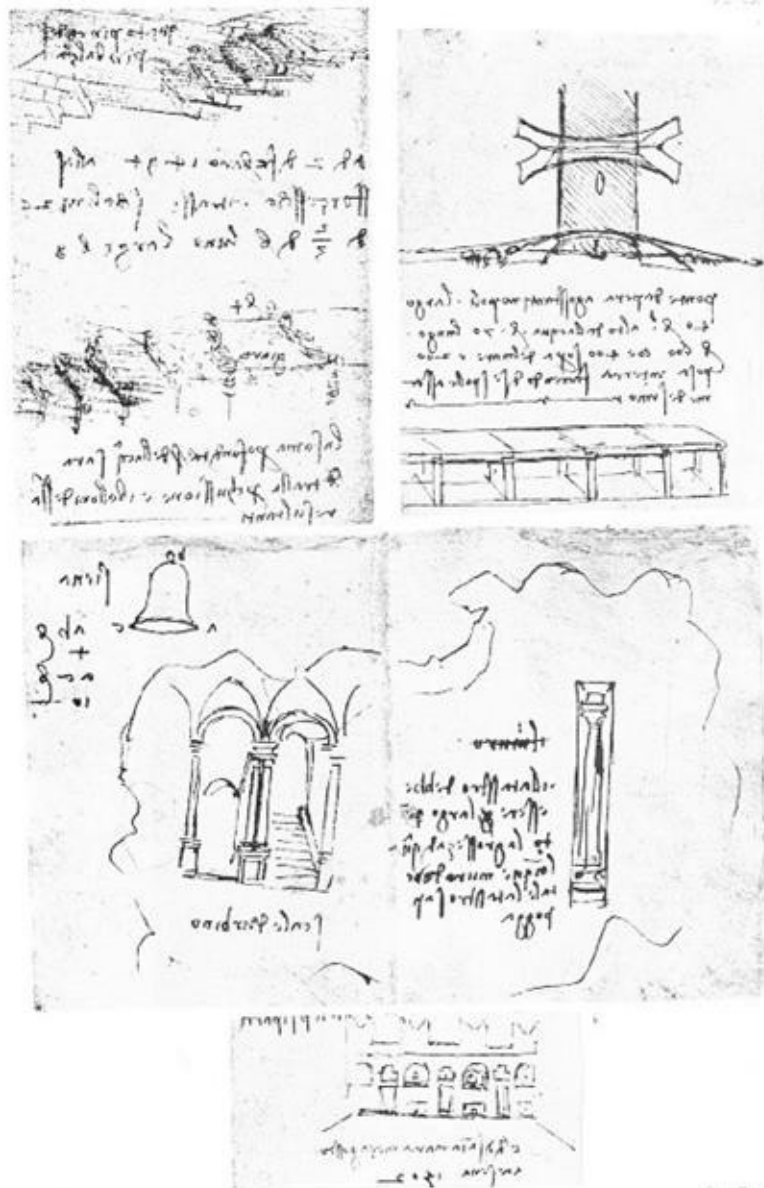


PLATE CXI

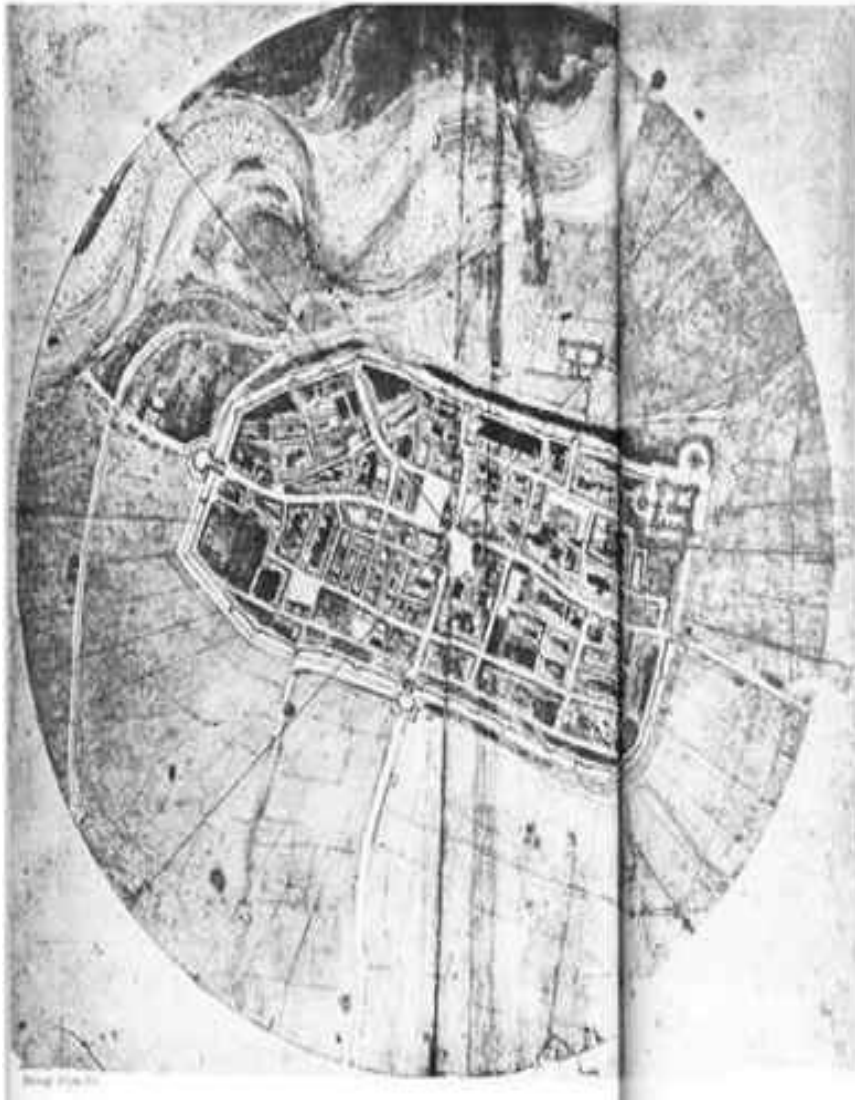
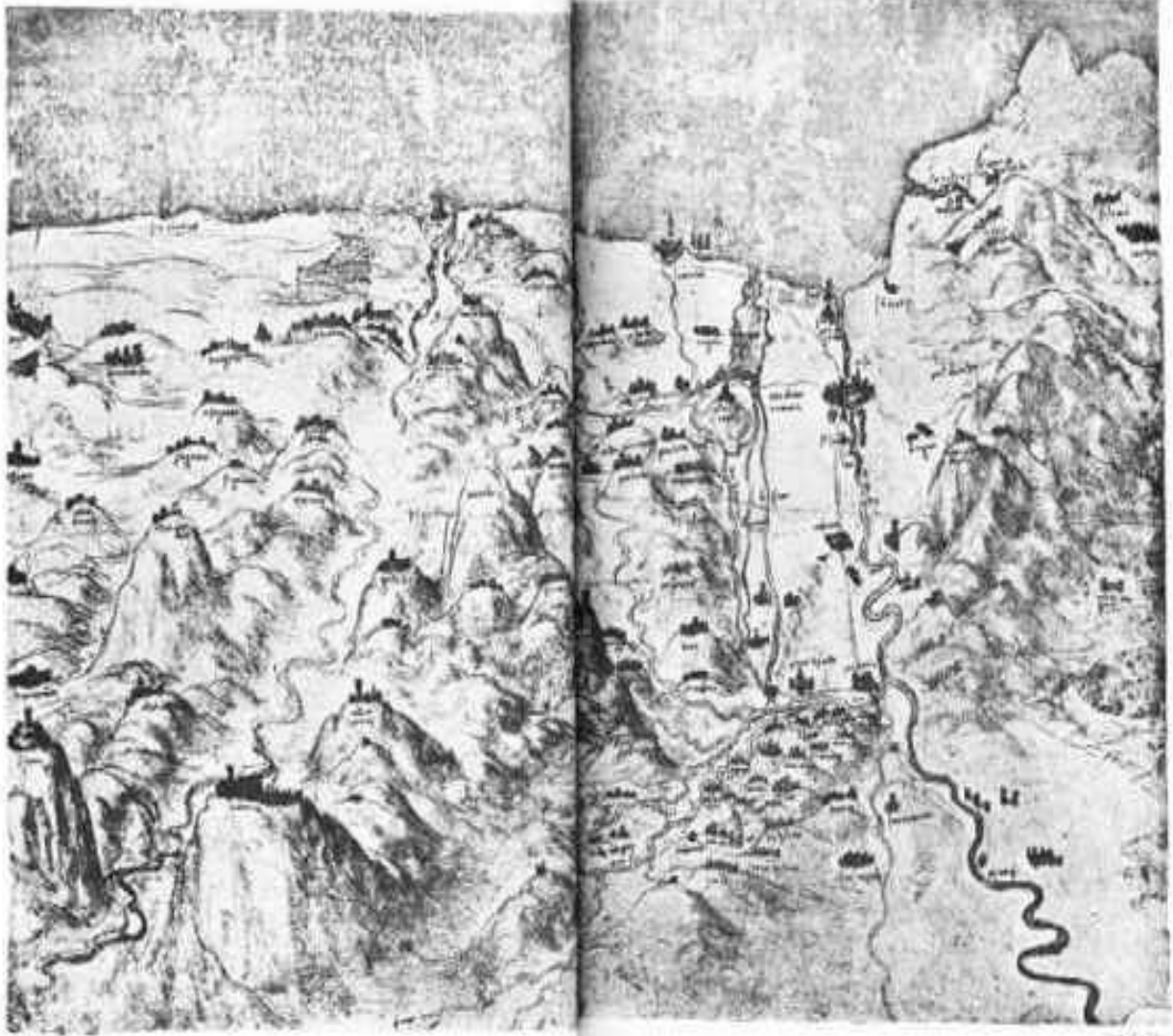


PLATE CXII



Along the river

Fig. 100

PLATE CXIII

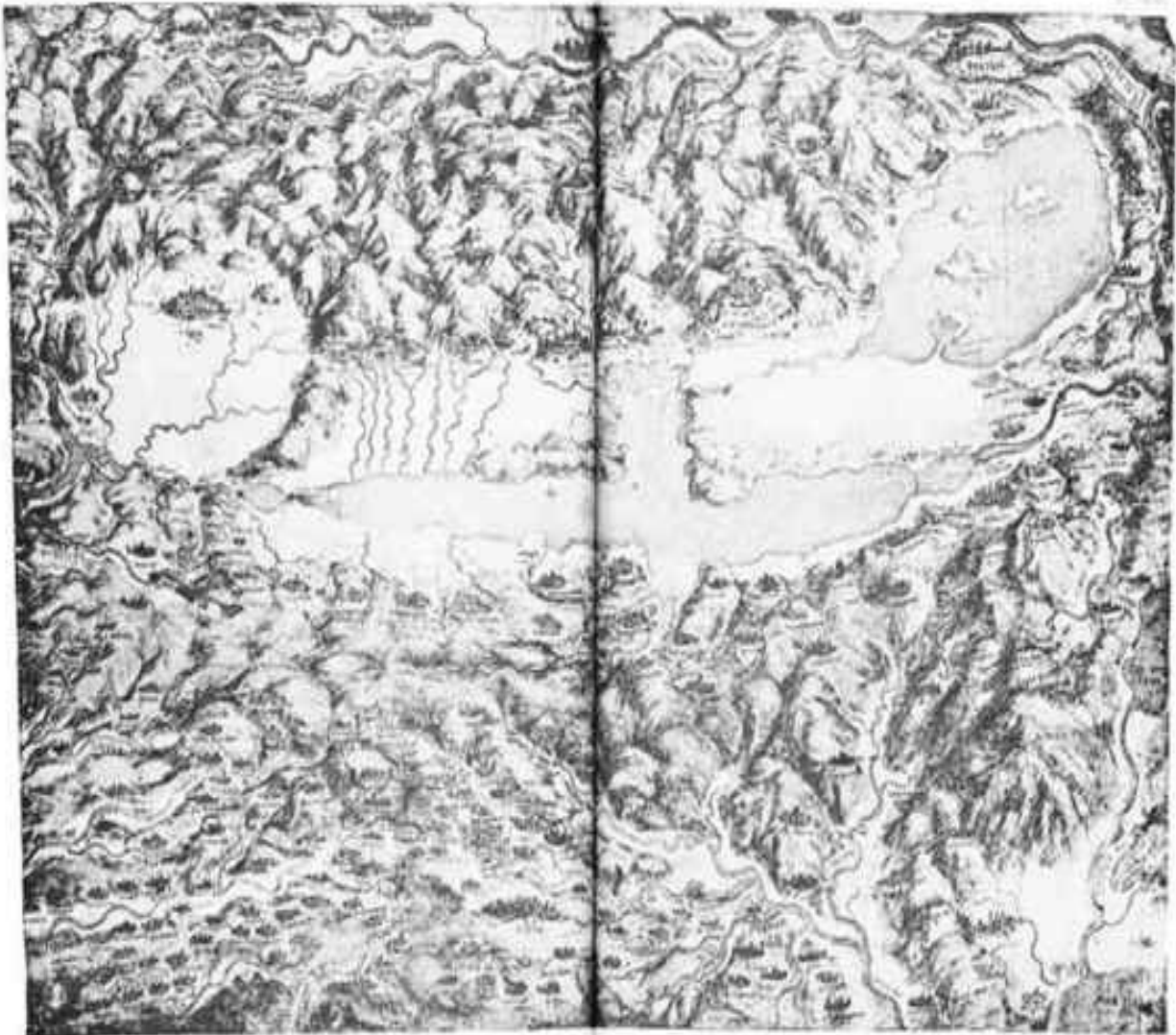


PLATE CXIV

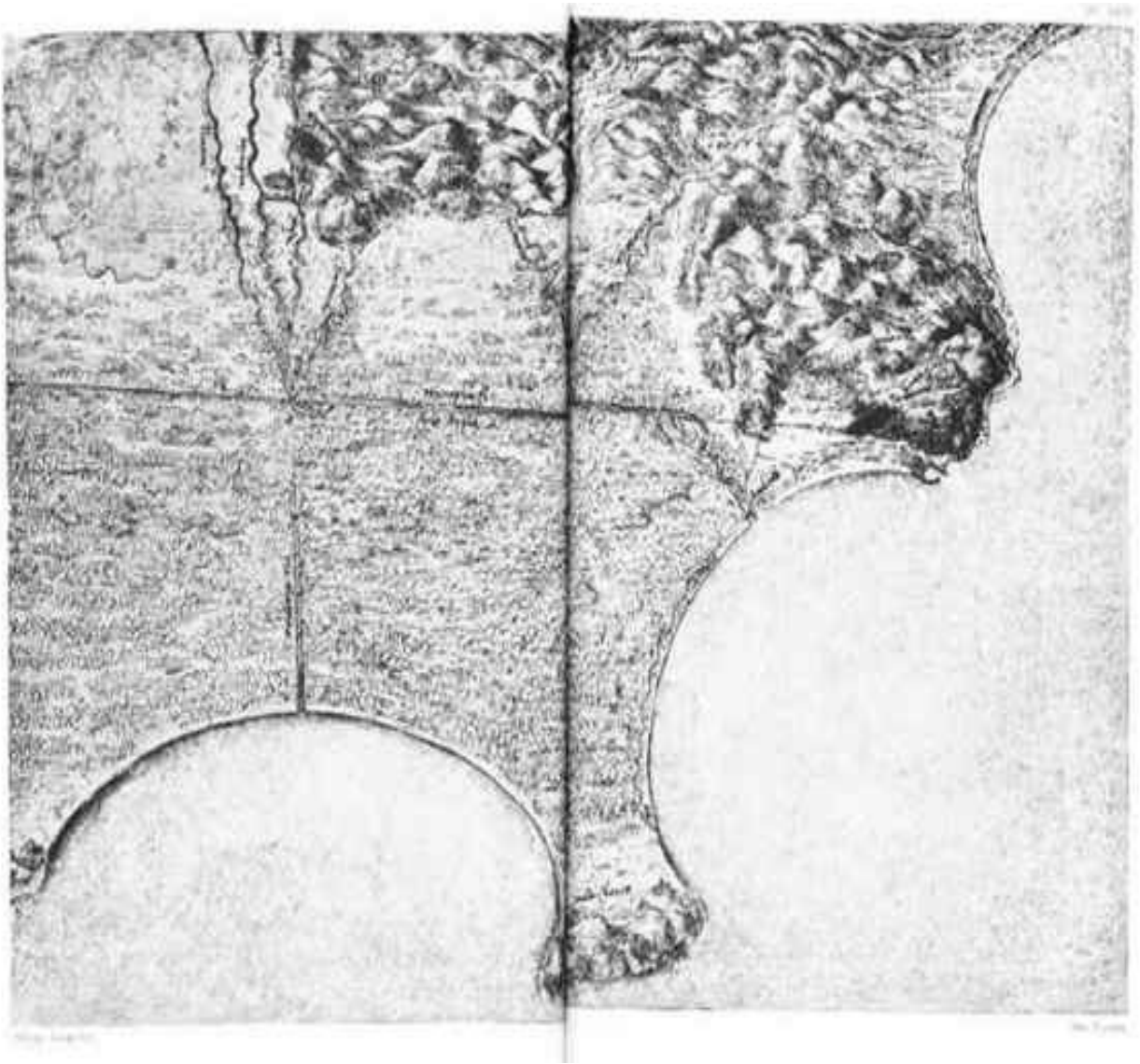


PLATE CXV

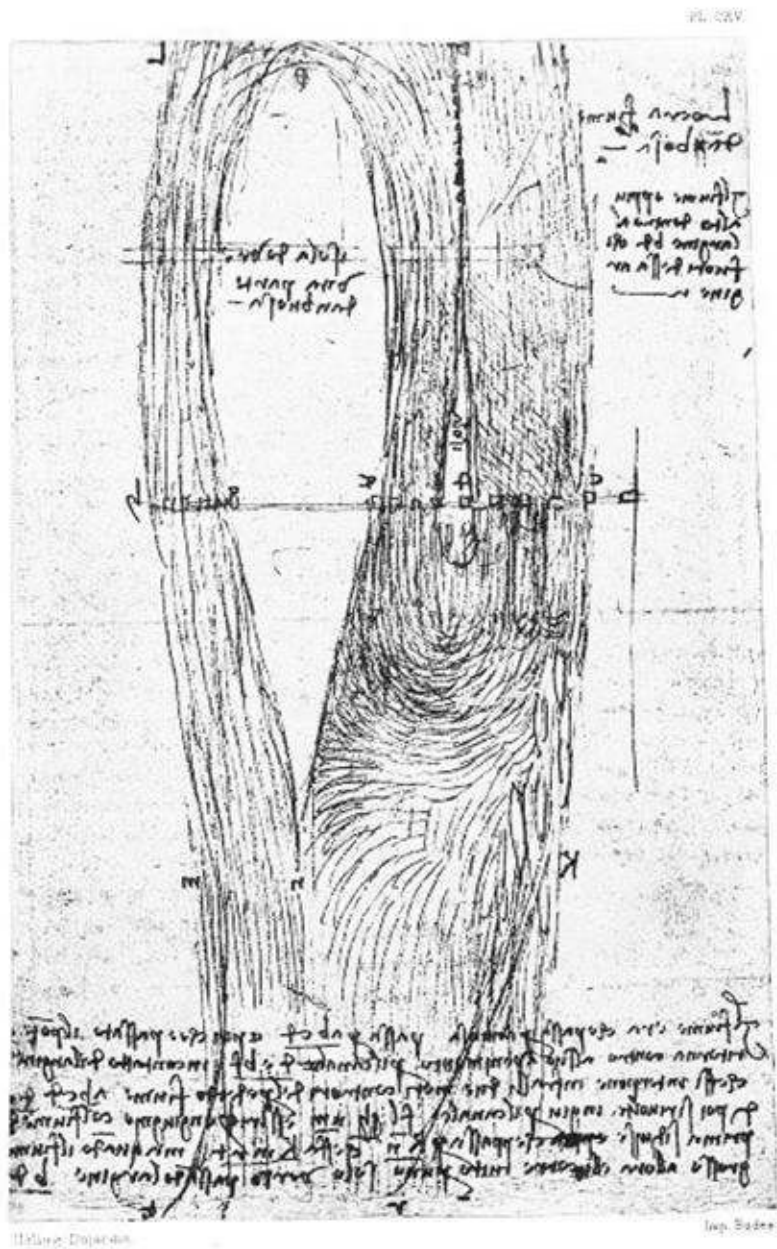


PLATE CXVI



PLATE CXVII



PLATE CXVIII



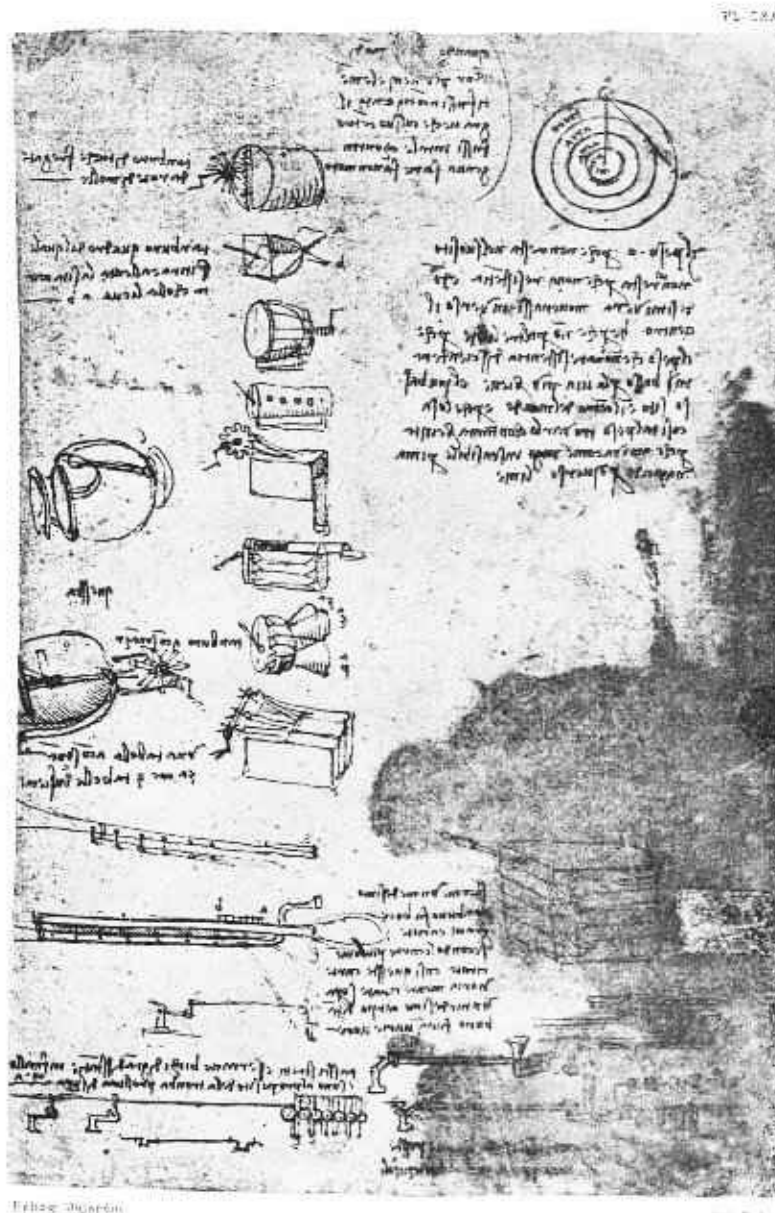
PLATE CXIX



PLATE CXX



PLATE CXXI



תבנית המכונה

המכונה

PLATE CXXII



Plato, Aristotle

Top: Plato

VOLUME I

PREFACE.

A singular fatality has ruled the destiny of nearly all the most famous of Leonardo da Vinci's works. Two of the three most important were never completed, obstacles having arisen during his life-time, which obliged him to leave them unfinished; namely the Sforza Monument and the Wall-painting of the Battle of Anghiari, while the third — the picture of the Last Supper at Milan — has suffered irremediable injury from decay and the repeated restorations to which it was recklessly subjected during the XVIIth and XVIIIth centuries. Nevertheless, no other picture of the Renaissance has become so wellknown and popular through copies of every description.

Vasari says, and rightly, in his Life of Leonardo, "that he laboured much more by his word than in fact or by deed", and the biographer evidently had in his mind the numerous works in Manuscript which have been preserved to this day. To us, now, it seems almost inexplicable that these valuable and interesting original texts should have remained so long unpublished, and indeed forgotten. It is certain that during the XVIth and XVIIth centuries their exceptional value was highly appreciated. This is proved not merely by the prices which they commanded, but also by the exceptional interest which has been attached to the change of ownership of merely a few pages of Manuscript.

That, notwithstanding this eagerness to possess the Manuscripts, their contents remained a mystery, can only be accounted for by the many and great difficulties attending the task of deciphering them. The handwriting is so peculiar that it requires considerable practice to read even a few detached phrases, much more to solve with any certainty the numerous difficulties of alternative readings, and to master the sense as a connected whole. Vasari observes with reference to Leonardos writing: "he wrote backwards, in rude characters, and with the left hand, so that any one who is not practised in reading them, cannot understand them". The aid of a mirror in reading reversed handwriting appears to me available only for a first experimental reading. Speaking from my own experience, the persistent use of it is too fatiguing and inconvenient to be practically advisable, considering the enormous mass of Manuscripts to be deciphered. And as, after all, Leonardo's handwriting runs backwards just as all Oriental character runs backwards — that is to say from right to left — the difficulty of reading direct from the writing is not insuperable. This obvious

peculiarity in the writing is not, however, by any means the only obstacle in the way of mastering the text. Leonardo made use of an orthography peculiar to himself; he had a fashion of amalgamating several short words into one long one, or, again, he would quite arbitrarily divide a long word into two separate halves; added to this there is no punctuation whatever to regulate the division and construction of the sentences, nor are there any accents — and the reader may imagine that such difficulties were almost sufficient to make the task seem a desperate one to a beginner. It is therefore not surprising that the good intentions of some of Leonardo's most reverent admirers should have failed.

Leonardo's literary labours in various departments both of Art and of Science were those essentially of an enquirer, hence the analytical method is that which he employs in arguing out his investigations and dissertations. The vast structure of his scientific theories is consequently built up of numerous separate researches, and it is much to be lamented that he should never have collated and arranged them. His love for detailed research — as it seems to me — was the reason that in almost all the Manuscripts, the different paragraphs appear to us to be in utter confusion; on one and the same page, observations on the most dissimilar subjects follow each other without any connection. A page, for instance, will begin with some principles of astronomy, or the motion of the earth; then come the laws of sound, and finally some precepts as to colour. Another page will begin with his investigations on the structure of the intestines, and end with philosophical remarks as to the relations of poetry to painting; and so forth.

Leonardo himself lamented this confusion, and for that reason I do not think that the publication of the texts in the order in which they occur in the originals would at all fulfil his intentions. No reader could find his way through such a labyrinth; Leonardo himself could not have done it.

Added to this, more than half of the five thousand manuscript pages which now remain to us, are written on loose leaves, and at present arranged in a manner which has no justification beyond the fancy of the collector who first brought them together to make volumes of more or less extent. Nay, even in the volumes, the pages of which were numbered by Leonardo himself, their order, so far as the connection of the texts was concerned, was obviously a matter of indifference to him. The only point he seems to have kept in view, when first writing down his notes, was that each observation should be complete to the end on the page on which it was begun. The exceptions to this rule are extremely few, and it is certainly noteworthy that we find in such cases, in bound volumes with his numbered pages, the written observations: “turn over”, “This is the continuation of the previous page”, and the like. Is not this sufficient to prove

that it was only in quite exceptional cases that the writer intended the consecutive pages to remain connected, when he should, at last, carry out the often planned arrangement of his writings?

What this final arrangement was to be, Leonardo has in most cases indicated with considerable completeness. In other cases this authoritative clue is wanting, but the difficulties arising from this are not insuperable; for, as the subject of the separate paragraphs is always distinct and well defined in itself, it is quite possible to construct a well-planned whole, out of the scattered materials of his scientific system, and I may venture to state that I have devoted especial care and thought to the due execution of this responsible task.

The beginning of Leonardo's literary labours dates from about his thirty-seventh year, and he seems to have carried them on without any serious interruption till his death. Thus the Manuscripts that remain represent a period of about thirty years. Within this space of time his handwriting altered so little that it is impossible to judge from it of the date of any particular text. The exact dates, indeed, can only be assigned to certain note-books in which the year is incidentally indicated, and in which the order of the leaves has not been altered since Leonardo used them. The assistance these afford for a chronological arrangement of the Manuscripts is generally self evident. By this clue I have assigned to the original Manuscripts now scattered through England, Italy and France, the order of their production, as in many matters of detail it is highly important to be able to verify the time and place at which certain observations were made and registered. For this purpose the Bibliography of the Manuscripts given at the end of Vol. II, may be regarded as an Index, not far short of complete, of all Leonardo's literary works now extant. The consecutive numbers (from 1 to 1566) at the head of each passage in this work, indicate their logical sequence with reference to the subjects; while the letters and figures to the left of each paragraph refer to the original Manuscript and number of the page, on which that particular passage is to be found. Thus the reader, by referring to the List of Manuscripts at the beginning of Volume I, and to the Bibliography at the end of Volume II, can, in every instance, easily ascertain, not merely the period to which the passage belongs, but also exactly where it stood in the original document. Thus, too, by following the sequence of the numbers in the Bibliographical index, the reader may reconstruct the original order of the Manuscripts and recompose the various texts to be found on the original sheets — so much of it, that is to say, as by its subject-matter came within the scope of this work. It may, however, be here observed that Leonardo's Manuscripts contain, besides the passages here printed, a great number of notes and dissertations on Mechanics, Physics, and some other subjects, many of which

could only be satisfactorily dealt with by specialists. I have given as complete a review of these writings as seemed necessary in the Bibliographical notes.

In 1651, Raphael Trichet Dufresne, of Paris, published a selection from Leonardo's writings on painting, and this treatise became so popular that it has since been reprinted about two-and-twenty times, and in six different languages. But none of these editions were derived from the original texts, which were supposed to have been lost, but from early copies, in which Leonardo's text had been more or less mutilated, and which were all fragmentary. The oldest and on the whole the best copy of Leonardo's essays and precepts on Painting is in the Vatican Library; this has been twice printed, first by Manzi, in 1817, and secondly by Ludwig, in 1882. Still, this ancient copy, and the published editions of it, contain much for which it would be rash to hold Leonardo responsible, and some portions — such as the very important rules for the proportions of the human figure — are wholly wanting; on the other hand they contain passages which, if they are genuine, cannot now be verified from any original Manuscript extant. These copies, at any rate neither give us the original order of the texts, as written by Leonardo, nor do they afford any substitute, by connecting them on a rational scheme; indeed, in their chaotic confusion they are anything rather than satisfactory reading. The fault, no doubt, rests with the compiler of the Vatican copy, which would seem to be the source whence all the published and extensively known texts were derived; for, instead of arranging the passages himself, he was satisfied with recording a suggestion for a final arrangement of them into eight distinct parts, without attempting to carry out his scheme. Under the mistaken idea that this plan of distribution might be that, not of the compiler, but of Leonardo himself, the various editors, down to the present day, have very injudiciously continued to adopt this order — or rather disorder.

I, like other enquirers, had given up the original Manuscript of the *Trattato della Pittura* for lost, till, in the beginning of 1880, I was enabled, by the liberality of Lord Ashburnham, to inspect his Manuscripts, and was so happy as to discover among them the original text of the best-known portion of the *Trattato* in his magnificent library at Ashburnham Place. Though this discovery was of a fragment only — but a considerable fragment — inciting me to further search, it gave the key to the mystery which had so long enveloped the first origin of all the known copies of the *Trattato*. The extensive researches I was subsequently enabled to prosecute, and the results of which are combined in this work, were only rendered possible by the unrestricted permission granted me to investigate all the Manuscripts by Leonardo dispersed throughout Europe, and to reproduce the highly important original sketches they contain, by the process of "photogravure". Her Majesty the Queen graciously accorded me special

permission to copy for publication the Manuscripts at the Royal Library at Windsor. The Commission Centrale Administrative de l'Institut de France, Paris, gave me, in the most liberal manner, in answer to an application from Sir Frederic Leighton, P. R. A., Corresponding member of the Institut, free permission to work for several months in their private collection at deciphering the Manuscripts preserved there. The same favour which Lord Ashburnham had already granted me was extended to me by the Earl of Leicester, the Marchese Trivulsi, and the Curators of the Ambrosian Library at Milan, by the Conte Manzoni at Rome and by other private owners of Manuscripts of Leonardo's; as also by the Directors of the Louvre at Paris; the Accademia at Venice; the Uffizi at Florence; the Royal Library at Turin; and the British Museum, and the South Kensington Museum. I am also greatly indebted to the Librarians of these various collections for much assistance in my labours; and more particularly to Monsieur Louis Lalanne, of the Institut de France, the Abbate Ceriani, of the Ambrosian Library, Mr. Maude Thompson, Keeper of Manuscripts at the British Museum, Mr. Holmes, the Queens Librarian at Windsor, the Revd Vere Bayne, Librarian of Christ Church College at Oxford, and the Revd A. Napier, Librarian to the Earl of Leicester at Holkham Hall.

In correcting the Italian text for the press, I have had the advantage of valuable advice from the Commendatore Giov. Morelli, Senatore del Regno, and from Signor Gustavo Frizzoni, of Milan. The translation, under many difficulties, of the Italian text into English, is mainly due to Mrs. R. C. Bell; while the rendering of several of the most puzzling and important passages, particularly in the second half of Vol. I, I owe to the indefatigable interest taken in this work by Mr. E. J. Poynter R. A. Finally I must express my thanks to Mr. Alfred Marks, of Long Ditton, who has most kindly assisted me throughout in the revision of the proof sheets.

The notes and dissertations on the texts on Architecture in Vol. II

I owe to my friend Baron Henri de Geymuller, of Paris.

I may further mention with regard to the illustrations, that the negatives for the production of the "photogravures" by Monsieur Dujardin of Paris were all taken direct from the originals.

It is scarcely necessary to add that most of the drawings here reproduced in facsimile have never been published before. As I am now, on the termination of a work of several years' duration, in a position to review the general tenour of Leonardos writings, I may perhaps be permitted to add a word as to my own estimate of the value of their contents. I have already shown that it is due to nothing but a fortuitous succession of unfortunate circumstances, that we should not, long since, have known Leonardo, not merely as a Painter, but as an Author,

a Philosopher, and a Naturalist. There can be no doubt that in more than one department his principles and discoveries were infinitely more in accord with the teachings of modern science, than with the views of his contemporaries. For this reason his extraordinary gifts and merits are far more likely to be appreciated in our own time than they could have been during the preceding centuries. He has been unjustly accused of having squandered his powers, by beginning a variety of studies and then, having hardly begun, throwing them aside. The truth is that the labours of three centuries have hardly sufficed for the elucidation of some of the problems which occupied his mighty mind.

Alexander von Humboldt has borne witness that “he was the first to start on the road towards the point where all the impressions of our senses converge in the idea of the Unity of Nature” Nay, yet more may be said. The very words which are inscribed on the monument of Alexander von Humboldt himself, at Berlin, are perhaps the most appropriate in which we can sum up our estimate of Leonardo’s genius:

“Majestati naturae par ingenium.”

LONDON, April 1883.

I. PROLEGOMENA AND GENERAL INTRODUCTION TO THE BOOK ON PAINTING

THE AUTHOR'S INTENTION TO PUBLISH HIS MSS.

1.

How by a certain machine many may stay some time under water. And how and wherefore I do not describe my method of remaining under water and how long I can remain without eating. And I do not publish nor divulge these, by reason of the evil nature of men, who would use them for assassinations at the bottom of the sea by destroying ships, and sinking them, together with the men in them. Nevertheless I will impart others, which are not dangerous because the mouth of the tube through which you breathe is above the water, supported on air sacks or cork.

[Footnote: The leaf on which this passage is written, is headed with the words *Casi* 39, and most of these cases begin with the word '*Come*', like the two here given, which are the 26th and 27th. 7. *Sughero*. In the Codex Antlanticus 377a; 1170a there is a sketch, drawn with the pen, representing a man with a tube in his mouth, and at the farther end of the tube a disk. By the tube the word '*Channa*' is written, and by the disk the word '*sughero*'.]

The preparation of the MSS. for publication.

2.

When you put together the science of the motions of water, remember to include under each proposition its application and use, in order that this science may not be useless. —

[Footnote: A comparatively small portion of Leonardo's notes on water-power was published at Bologna in 1828, under the title: "*Del moto e misura dell'Acqua, di L. da Vinci*".]

Admonition to readers.

3.

Let no man who is not a Mathematician read the elements of my work.
The disorder in the MSS.

4.

Begun at Florence, in the house of Piero di Braccio Martelli, on the 22nd day of March 1508. And this is to be a collection without order, taken from many papers which I have copied here, hoping to arrange them later each in its place, according to the subjects of which they may treat. But I believe that before I am at the end of this [task] I shall have to repeat the same things several times; for which, O reader! do not blame me, for the subjects are many and memory cannot retain them [all] and say: 'I will not write this because I wrote it before.' And if I wished to avoid falling into this fault, it would be necessary in every case when I wanted to copy [a passage] that, not to repeat myself, I should read over all that had gone before; and all the more since the intervals are long between one time of writing and the next.

[Footnote: 1. In the history of Florence in the early part of the XVIth century *Piero di Braccio Martelli* is frequently mentioned as *Commissario della Signoria*. He was famous for his learning and at his death left four books on Mathematics ready for the press; comp. LITTA, *Famiglie celebri Italiane*, *Famiglia Martelli di Firenze*. — In the Official Catalogue of MSS. in the Brit. Mus., New Series Vol. I., where this passage is printed, *Barto* has been wrongly given for Braccio.

2. *addi 22 di marzo 1508*. The Christian era was computed in Florence at that time from the Incarnation (Lady day, March 25th). Hence this should be 1509 by our reckoning.

3. *racolto tratto di molte carte le quali io ho qui copiate*. We must suppose that Leonardo means that he has copied out his own MSS. and not those of others. The first thirteen leaves of the MS. in the Brit. Mus. are a fair copy of some notes on physics.]

Suggestions for the arrangement of MSS treating of particular subjects.(5-8).

5.

Of digging a canal. Put this in the Book of useful inventions and in proving them bring forward the propositions already proved. And this is the proper order; since if you wished to show the usefulness of any plan you would be obliged again to devise new machines to prove its utility and thus would confuse the order of the forty Books and also the order of the diagrams; that is to say you would have to mix up practice with theory, which would produce a confused and incoherent work.

6.

I am not to blame for putting forward, in the course of my work on science, any general rule derived from a previous conclusion.

7.

The Book of the science of Mechanics must precede the Book of useful inventions. — Have your books on anatomy bound! [Footnote: 4. The numerous notes on anatomy written on loose leaves and now in the Royal collection at Windsor can best be classified in four Books, corresponding to the different character and size of the paper. When Leonardo speaks of '*li tua libri di notomia*', he probably means the MSS. which still exist; if this hypothesis is correct the present condition of these leaves might seem to prove that he only carried out his purpose with one of the Books on anatomy. A borrowed book on Anatomy is mentioned in F.O.]

8.

The order of your book must proceed on this plan: first simple beams, then (those) supported from below, then suspended in part, then wholly [suspended]. Then beams as supporting other weights [Footnote: 4. Leonardo's notes on Mechanics are extraordinarily numerous; but, for the reasons assigned in my introduction, they have not been included in the present work.].

General introductions to the book on Painting (9-13).

9.

INTRODUCTION.

Seeing that I can find no subject specially useful or pleasing — since the men who have come before me have taken for their own every useful or necessary theme — I must do like one who, being poor, comes last to the fair, and can find no other way of providing himself than by taking all the things already seen by other buyers, and not taken but refused by reason of their lesser value. I, then, will load my humble pack with this despised and rejected merchandise, the refuse of so many buyers; and will go about to distribute it, not indeed in great cities, but in the poorer towns, taking such a price as the wares I offer may be worth. [Footnote: It need hardly be pointed out that there is in this ‘Proemio’ a covert irony. In the second and third prefaces, Leonardo characterises his rivals and opponents more closely. His protest is directed against Neo-latinism as professed by most of the humanists of his time; its futility is now no longer questioned.]

I know that many will call this useless work [Footnote: 3. questa essere opera inutile. By opera we must here understand libro di pittura and particularly the treatise on Perspective.]; and they will be those of whom Demetrius [Footnote: 4. Demetrio. “With regard to the passage attributed to Demetrius”, Dr. H. MÜLLER STRÜBING writes, “I know not what to make of it. It is certainly not Demetrius Phalereus that is meant and it can hardly be Demetrius Poliorcetes. Who then can it be — for the name is a very common one? It may be a clerical error for Demades and the maxim is quite in the spirit of his writings I have not however been able to find any corresponding passage either in the ‘Fragments’ (C. MULLER, *Orat. Att.*, II. 441) nor in the Supplements collected by DIETZ (*Rhein. Mus.*, vol. 29, p. 108).”

The same passage occurs as a simple Memorandum in the MS. Tr. 57, apparently as a note for this ‘Proemio’ thus affording some data as to the time where these introductions were written.] declared that he took no more account of the wind that came out their mouth in words, than of that they expelled from their lower parts: men who desire nothing but material riches and are absolutely devoid of that of wisdom, which is the food and the only true riches of the mind. For so much more worthy as the soul is than the body, so much more noble are the possessions of the soul than those of the body. And often, when I see one of these men take this work in his hand, I wonder that he does not put it to his nose, like a monkey, or ask me if it is something good to eat.

[Footnote: In the original, the Proemio di prospettiva cioè dell’uffitio dell’occhio (see No. 21) stands between this and the preceding one, No. 9.]

I am fully conscious that, not being a literary man, certain presumptuous persons will think that they may reasonably blame me; alleging that I am not a man of letters. Foolish folks! do they not know that I might retort as Marius did to the Roman Patricians [Footnote 21: *Come Mario disse ai patriti Romani*. “I am unable to find the words here attributed by Leonardo to Marius, either in Plutarch’s Life of Marius or in the Apophthegmata (*Moralia*, p.202). Nor do they occur in the writings of Valerius Maximus (who frequently mentions Marius) nor in Velleius Paterculus (II, 11 to 43), Dio Cassius, Aulus Gellius, or Macrobius. Professor E. MENDELSON of Dorpat, the editor of Herodian, assures me that no such passage is to be found in that author” (communication from Dr. MULLER STRUBING). Leonardo evidently meant to allude to some well known incident in Roman history and the mention of Marius is the result probably of some confusion. We may perhaps read, for Marius, Menenius Agrippa, though in that case it is true we must alter Patriti to Plebei. The change is a serious one. but it would render the passage perfectly clear.] by saying: That they, who deck themselves out in the labours of others will not allow me my own. They will say that I, having no literary skill, cannot properly express that which I desire to treat of [Footnote 26: *le mie cose che d’altra parola*. This can hardly be reconciled with Mons. RAVAISSON’S estimate of L. da Vinci’s learning. “*Leonard de Vinci etait un admirateur et un disciple des anciens, aussi bien dans l’art que dans la science et il tenait a passer pour tel meme aux yeux de la posterite.*” *Gaz. des Beaux arts*. Oct. 1877.]; but they do not know that my subjects are to be dealt with by experience rather than by words [Footnote 28: See Footnote 26]; and [experience] has been the mistress of those who wrote well. And so, as mistress, I will cite her in all cases.

Though I may not, like them, be able to quote other authors, I shall rely on that which is much greater and more worthy: — on experience, the mistress of their Masters. They go about puffed up and pompous, dressed and decorated with [the fruits], not of their own labours, but of those of others. And they will not allow me my own. They will scorn me as an inventor; but how much more might they — who are not inventors but vaunters and declaimers of the works of others — be blamed.

INTRODUCTION.

And those men who are inventors and interpreters between Nature and Man, as compared with boasters and declaimers of the works of others, must be regarded and not otherwise esteemed than as the object in front of a mirror, when

compared with its image seen in the mirror. For the first is something in itself, and the other nothingness. — Folks little indebted to Nature, since it is only by chance that they wear the human form and without it I might class them with the herds of beasts.

Many will think they may reasonably blame me by alleging that my proofs are opposed to the authority of certain men held in the highest reverence by their inexperienced judgments; not considering that my works are the issue of pure and simple experience, who is the one true mistress. These rules are sufficient to enable you to know the true from the false — and this aids men to look only for things that are possible and with due moderation — and not to wrap yourself in ignorance, a thing which can have no good result, so that in despair you would give yourself up to melancholy.

13.

Among all the studies of natural causes and reasons Light chiefly delights the beholder; and among the great features of Mathematics the certainty of its demonstrations is what preeminently (tends to) elevate the mind of the investigator. Perspective, therefore, must be preferred to all the discourses and systems of human learning. In this branch [of science] the beam of light is explained on those methods of demonstration which form the glory not so much of Mathematics as of Physics and are graced with the flowers of both [Footnote: 5. Such of Leonardo's notes on Optics or on Perspective as bear exclusively on Mathematics or Physics could not be included in the arrangement of the *libro di pittura* which is here presented to the reader. They are however but few.]. But its axioms being laid down at great length, I shall abridge them to a conclusive brevity, arranging them on the method both of their natural order and of mathematical demonstration; sometimes by deduction of the effects from the causes, and sometimes arguing the causes from the effects; adding also to my own conclusions some which, though not included in them, may nevertheless be inferred from them. Thus, if the Lord — who is the light of all things — vouchsafe to enlighten me, I will treat of Light; wherefore I will divide the present work into 3 Parts [Footnote: 10. In the middle ages — for instance, by ROGER BACON, by VITELLONE, with whose works Leonardo was certainly familiar, and by all the writers of the Renaissance Perspective and Optics were not regarded as distinct sciences. Perspective, indeed, is in its widest application the science of seeing. Although to Leonardo the two sciences were clearly separate, it is not so as to their names; thus we find axioms in Optics under the

heading Perspective. According to this arrangement of the materials for the theoretical portion of the *libro di pittura* propositions in Perspective and in Optics stand side by side or occur alternately. Although this particular chapter deals only with Optics, it is not improbable that the words *partirò la presente opera in 3 parti* may refer to the same division into three sections which is spoken of in chapters 14 to 17.].

The plan of the book on Painting (14 — 17).

14.

ON THE THREE BRANCHES OF PERSPECTIVE.

There are three branches of perspective; the first deals with the reasons of the (apparent) diminution of objects as they recede from the eye, and is known as Diminishing Perspective. — The second contains the way in which colours vary as they recede from the eye. The third and last is concerned with the explanation of how the objects [in a picture] ought to be less finished in proportion as they are remote (and the names are as follows):

Linear Perspective. The Perspective of Colour. The Perspective of Disappearance.

[Footnote: 13. From the character of the handwriting I infer that this passage was written before the year 1490.].

15.

ON PAINTING AND PERSPECTIVE.

The divisions of Perspective are 3, as used in drawing; of these, the first includes the diminution in size of opaque objects; the second treats of the diminution and loss of outline in such opaque objects; the third, of the diminution and loss of colour at long distances.

[Footnote: The division is here the same as in the previous chapter No. 14, and this is worthy of note when we connect it with the fact that a space of about 20

years must have intervened between the writing of the two passages.]

16.

THE DISCOURSE ON PAINTING.

Perspective, as bearing on drawing, is divided into three principal sections; of which the first treats of the diminution in the size of bodies at different distances. The second part is that which treats of the diminution in colour in these objects. The third [deals with] the diminished distinctness of the forms and outlines displayed by the objects at various distances.

17.

ON THE SECTIONS OF [THE BOOK ON] PAINTING.

The first thing in painting is that the objects it represents should appear in relief, and that the grounds surrounding them at different distances shall appear within the vertical plane of the foreground of the picture by means of the 3 branches of Perspective, which are: the diminution in the distinctness of the forms of the objects, the diminution in their magnitude; and the diminution in their colour. And of these 3 classes of Perspective the first results from [the structure of] the eye, while the other two are caused by the atmosphere which intervenes between the eye and the objects seen by it. The second essential in painting is appropriate action and a due variety in the figures, so that the men may not all look like brothers, &c.

[Footnote: This and the two foregoing chapters must have been written in 1513 to 1516. They undoubtedly indicate the scheme which Leonardo wished to carry out in arranging his researches on Perspective as applied to Painting. This is important because it is an evidence against the supposition of H. LUDWIG and others, that Leonardo had collected his principles of Perspective in one book so early as before 1500; a Book which, according to the hypothesis, must have been lost at a very early period, or destroyed possibly, by the French (!) in 1500

(see H. LUDWIG. L. da Vinci: *Das Buch van der Malerei*. Vienna 1882 III, 7 and 8).]

The use of the book on Painting.

18.

These rules are of use only in correcting the figures; since every man makes some mistakes in his first compositions and he who knows them not, cannot amend them. But you, knowing your errors, will correct your works and where you find mistakes amend them, and remember never to fall into them again. But if you try to apply these rules in composition you will never make an end, and will produce confusion in your works.

These rules will enable you to have a free and sound judgment; since good judgment is born of clear understanding, and a clear understanding comes of reasons derived from sound rules, and sound rules are the issue of sound experience — the common mother of all the sciences and arts. Hence, bearing in mind the precepts of my rules, you will be able, merely by your amended judgment, to criticise and recognise every thing that is out of proportion in a work, whether in the perspective or in the figures or any thing else.

Necessity of theoretical knowledge (19. 20).

19.

OF THE MISTAKES MADE BY THOSE WHO PRACTISE WITHOUT KNOWLEDGE.

Those who are in love with practice without knowledge are like the sailor who gets into a ship without rudder or compass and who never can be certain whether he is going. Practice must always be founded on sound theory, and to this Perspective is the guide and the gateway; and without this nothing can be done well in the matter of drawing.

20.

The painter who draws merely by practice and by eye, without any reason, is like a mirror which copies every thing placed in front of it without being conscious of their existence.

The function of the eye (21-23).

21.

INTRODUCTION TO PERSPECTIVE: — THAT IS OF THE FUNCTION OF THE EYE.

Behold here O reader! a thing concerning which we cannot trust our forefathers, the ancients, who tried to define what the Soul and Life are — which are beyond proof, whereas those things, which can at any time be clearly known and proved by experience, remained for many ages unknown or falsely understood. The eye, whose function we so certainly know by experience, has, down to my own time, been defined by an infinite number of authors as one thing; but I find, by experience, that it is quite another. [Footnote 13: Compare the note to No. 70.]

[Footnote: In section 13 we already find it indicated that the study of Perspective and of Optics is to be based on that of the functions of the eye. Leonardo also refers to the science of the eye, in his astronomical researches, for instance in MS. F 25b '*Ordine del provare la terra essere una stella: Imprima definisce l'occhio*', &c. Compare also MS. E 15b and F 60b. The principles of astronomical perspective.]

22.

Here [in the eye] forms, here colours, here the character of every part of the universe are concentrated to a point; and that point is so marvellous a thing ... Oh! marvellous, O stupendous Necessity — by thy laws thou dost compel every effect to be the direct result of its cause, by the shortest path. These [indeed] are miracles;...

In so small a space it can be reproduced and rearranged in its whole expanse. Describe in your anatomy what proportion there is between the diameters of all the images in the eye and the distance from them of the crystalline lens.

23.

OF THE 10 ATTRIBUTES OF THE EYE, ALL CONCERNED IN PAINTING.

Painting is concerned with all the 10 attributes of sight; which are: — Darkness, Light, Solidity and Colour, Form and Position, Distance and Propinquity, Motion and Rest. This little work of mine will be a tissue [of the studies] of these attributes, reminding the painter of the rules and methods by which he should use his art to imitate all the works of Nature which adorn the world.

24.

ON PAINTING.

Variability of the eye.

1st. The pupil of the eye contracts, in proportion to the increase of light which is reflected in it. 2nd. The pupil of the eye expands in proportion to the diminution in the day light, or any other light, that is reflected in it. 3rd. [Footnote: 8. The subject of this third proposition we find fully discussed in MS. G. 44a.]. The eye perceives and recognises the objects of its vision with greater intensity in proportion as the pupil is more widely dilated; and this can be proved by the case of nocturnal animals, such as cats, and certain birds — as the owl and others — in which the pupil varies in a high degree from large to small, &c., when in the dark or in the light. 4th. The eye [out of doors] in an illuminated atmosphere sees darkness behind the windows of houses which [nevertheless] are light. 5th. All colours when placed in the shade appear of an equal degree of darkness, among themselves. 6th. But all colours when placed in a full light, never vary from their true and essential hue.

25.

OF THE EYE.

Focus of sight.

If the eye is required to look at an object placed too near to it, it cannot judge of it well — as happens to a man who tries to see the tip of his nose. Hence, as a general rule, Nature teaches us that an object can never be seen perfectly unless the space between it and the eye is equal, at least, to the length of the face.

Differences of perception by one eye and by both eyes (26-29).

26.

OF THE EYE.

When both eyes direct the pyramid of sight to an object, that object becomes clearly seen and comprehended by the eyes.

27.

Objects seen by one and the same eye appear sometimes large, and sometimes small.

28.

The motion of a spectator who sees an object at rest often makes it seem as though the object at rest had acquired the motion of the moving body, while the moving person appears to be at rest.

ON PAINTING.

Objects in relief, when seen from a short distance with one eye, look like a perfect picture. If you look with the eye *a*, *b* at the spot *c*, this point *c* will appear to be at *d*, *f*, and if you look at it with the eye *g*, *h* will appear to be at *m*. A picture can never contain in itself both aspects.

29.

Let the object in relief t be seen by both eyes; if you will look at the object with the right eye m , keeping the left eye n shut, the object will appear, or fill up the space, at a ; and if you shut the right eye and open the left, the object (will occupy the) space b ; and if you open both eyes, the object will no longer appear at a or b , but at e , r , f . Why will not a picture seen by both eyes produce the effect of relief, as [real] relief does when seen by both eyes; and why should a picture seen with one eye give the same effect of relief as real relief would under the same conditions of light and shade?

[Footnote: In the sketch, m is the left eye and n the right, while the text reverses this lettering. We must therefore suppose that the face in which the eyes m and n are placed is opposite to the spectator.]

30.

The comparative size of the image depends on the amount of light (30-39).

The eye will hold and retain in itself the image of a luminous body better than that of a shaded object. The reason is that the eye is in itself perfectly dark and since two things that are alike cannot be distinguished, therefore the night, and other dark objects cannot be seen or recognised by the eye. Light is totally contrary and gives more distinctness, and counteracts and differs from the usual darkness of the eye, hence it leaves the impression of its image.

31.

Every object we see will appear larger at midnight than at midday, and larger in the morning than at midday.

This happens because the pupil of the eye is much smaller at midday than at any other time.

32.

The pupil which is largest will see objects the largest. This is evident when we look at luminous bodies, and particularly at those in the sky. When the eye

comes out of darkness and suddenly looks up at these bodies, they at first appear larger and then diminish; and if you were to look at those bodies through a small opening, you would see them smaller still, because a smaller part of the pupil would exercise its function.

[Footnote: 9. *buso* in the Lomb. dialect is the same as *buco*.]

33.

When the eye, coming out of darkness suddenly sees a luminous body, it will appear much larger at first sight than after long looking at it. The illuminated object will look larger and more brilliant, when seen with two eyes than with only one. A luminous object will appear smaller in size, when the eye sees it through a smaller opening. A luminous body of an oval form will appear rounder in proportion as it is farther from the eye.

34.

Why when the eye has just seen the light, does the half light look dark to it, and in the same way if it turns from the darkness the half light look very bright?

35.

ON PAINTING.

If the eye, when [out of doors] in the luminous atmosphere, sees a place in shadow, this will look very much darker than it really is. This happens only because the eye when out in the air contracts the pupil in proportion as the atmosphere reflected in it is more luminous. And the more the pupil contracts, the less luminous do the objects appear that it sees. But as soon as the eye enters into a shady place the darkness of the shadow suddenly seems to diminish. This occurs because the greater the darkness into which the pupil goes the more its size increases, and this increase makes the darkness seem less.

[Footnote 14: *La luce entrerà*. *Luce* occurs here in the sense of pupil of the eye as in no 51: C. A. 84b; 245a; I — 5; and in many other places.]

36.

ON PERSPECTIVE.

The eye which turns from a white object in the light of the sun and goes into a less fully lighted place will see everything as dark. And this happens either because the pupils of the eyes which have rested on this brilliantly lighted white object have contracted so much that, given at first a certain extent of surface, they will have lost more than $\frac{3}{4}$ of their size; and, lacking in size, they are also deficient in [seeing] power. Though you might say to me: A little bird (then) coming down would see comparatively little, and from the smallness of his pupils the white might seem black! To this I should reply that here we must have regard to the proportion of the mass of that portion of the brain which is given up to the sense of sight and to nothing else. Or — to return — this pupil in Man dilates and contracts according to the brightness or darkness of (surrounding) objects; and since it takes some time to dilate and contract, it cannot see immediately on going out of the light and into the shade, nor, in the same way, out of the shade into the light, and this very thing has already deceived me in painting an eye, and from that I learnt it.

37.

Experiment [showing] the dilatation and contraction of the pupil, from the motion of the sun and other luminaries. In proportion as the sky is darker the stars appear of larger size, and if you were to light up the medium these stars would look smaller; and this difference arises solely from the pupil which dilates and contracts with the amount of light in the medium which is interposed between the eye and the luminous body. Let the experiment be made, by placing a candle above your head at the same time that you look at a star; then gradually lower the candle till it is on a level with the ray that comes from the star to the eye, and then you will see the star diminish so much that you will almost lose sight of it.

[Footnote: No reference is made in the text to the letters on the accompanying diagram.]

38.

The pupil of the eye, in the open air, changes in size with every degree of motion from the sun; and at every degree of its changes one and the same object seen by it will appear of a different size; although most frequently the relative scale of surrounding objects does not allow us to detect these variations in any single object we may look at.

39.

The eye — which sees all objects reversed — retains the images for some time. This conclusion is proved by the results; because, the eye having gazed at light retains some impression of it. After looking (at it) there remain in the eye images of intense brightness, that make any less brilliant spot seem dark until the eye has lost the last trace of the impression of the stronger light.

II. LINEAR PERSPECTIVE.

We see clearly from the concluding sentence of section 49, where the author directly addresses the painter, that he must certainly have intended to include the elements of mathematics in his Book on the art of Painting. They are therefore here placed at the beginning. In section 50 the theory of the “Pyramid of Sight” is distinctly and expressly put forward as the fundamental principle of linear perspective, and sections 52 to 57 treat of it fully. This theory of sight can scarcely be traced to any author of antiquity. Such passages as occur in Euclid for instance, may, it is true, have proved suggestive to the painters of the Renaissance, but it would be rash to say any thing decisive on this point.

Leon Battista Alberti treats of the “Pyramid of Sight” at some length in his first Book of Painting; but his explanation differs widely from Leonardo’s in the details. Leonardo, like Alberti, may have borrowed the broad lines of his theory from some views commonly accepted among painters at the time; but he certainly worked out its application in a perfectly original manner.

The axioms as to the perception of the pyramid of rays are followed by explanations of its origin, and proofs of its universal application (58 — 69). The author recurs to the subject with endless variations; it is evidently of fundamental importance in his artistic theory and practice. It is unnecessary to discuss how far this theory has any scientific value at the present day; so much as this, at any rate, seems certain: that from the artist’s point of view it may still claim to be of immense practical utility.

According to Leonardo, on one hand, the laws of perspective are an inalienable condition of the existence of objects in space; on the other hand, by a natural law, the eye, whatever it sees and wherever it turns, is subjected to the perception of the pyramid of rays in the form of a minute target. Thus it sees objects in perspective independently of the will of the spectator, since the eye receives the images by means of the pyramid of rays “just as a magnet attracts iron”.

In connection with this we have the function of the eye explained by the Camera obscura, and this is all the more interesting and important because no writer previous to Leonardo had treated of this subject (70 — 73). *Subsequent passages, of no less special interest, betray his knowledge of refraction and of the inversion of the image in the camera and in the eye (74 — 82).*

From the principle of the transmission of the image to the eye and to the camera obscura he deduces the means of producing an artificial construction of the pyramid of rays or — which is the same thing — of the image. The fundamental axioms as to the angle of sight and the vanishing point are thus presented in a manner which is as complete as it is simple and intelligible (86 — 89).

Leonardo distinguishes between simple and complex perspective (90, 91). The last sections treat of the apparent size of objects at various distances and of the way to estimate it (92 — 109).

General remarks on perspective (40-41).

40.

ON PAINTING.

Perspective is the best guide to the art of Painting.

[Footnote: 40. Compare 53, 2.]

41.

The art of perspective is of such a nature as to make what is flat appear in relief and what is in relief flat.

The elements of perspective — Of the Point (42-46).

42.

All the problems of perspective are made clear by the five terms of mathematicians, which are: — the point, the line, the angle, the superficies and the solid. The point is unique of its kind. And the point has neither height, breadth, length, nor depth, whence it is to be regarded as indivisible and as having no dimensions in space. The line is of three kinds, straight, curved and sinuous and it has neither breadth, height, nor depth. Hence it is indivisible, excepting in its length, and its ends are two points. The angle is the junction of two lines in a point.

43.

A point is not part of a line.

44.

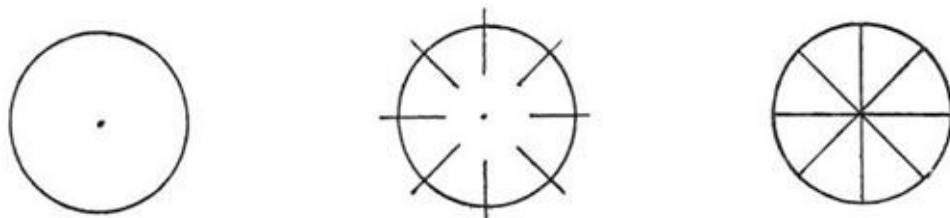
OF THE NATURAL POINT.

The smallest natural point is larger than all mathematical points, and this is proved because the natural point has continuity, and any thing that is continuous is infinitely divisible; but the mathematical point is indivisible because it has no size.

[Footnote: This definition was inserted by Leonardo on a MS. copy on parchment of the well-known "*Trattato d'Architettura civile e militare*" &c. by FRANCESCO DI GIORGIO; opposite a passage where the author says: 'In prima he da sapere che punto è quella parie della quale he nulla — Linia he luncheza senza àpieza; &c.']

45.

1, The superficies is a limitation of the body. 2, and the limitation of a body is no part of that body. 4, and the limitation of one body is that which begins another. 3, that which is not part of any body is nothing. Nothing is that which fills no space.



If one single point placed in a circle may be the starting point of an infinite number of lines, and the termination of an infinite number of lines, there must be an infinite number of points separable from this point, and these when reunited become one again; whence it follows that the part may be equal to the whole.

46.

The point, being indivisible, occupies no space. That which occupies no space is nothing. The limiting surface of one thing is the beginning of another. 2. That which is no part of any body is called nothing. 1. That which has no limitations, has no form. The limitations of two conterminous bodies are interchangeably the surface of each. All the surfaces of a body are not parts of that body.

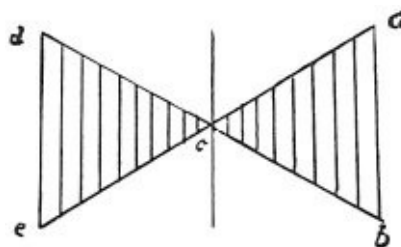
Of the line (47-48).

47.

DEFINITION OF THE NATURE OF THE LINE.

The line has in itself neither matter nor substance and may rather be called an imaginary idea than a real object; and this being its nature it occupies no space. Therefore an infinite number of lines may be conceived of as intersecting each other at a point, which has no dimensions and is only of the thickness (if thickness it may be called) of one single line.

HOW WE MAY CONCLUDE THAT A SUPERFICIES TERMINATES IN A POINT?



An angular surface is reduced to a point where it terminates in an angle. Or, if the sides of that angle are produced in a straight line, then — beyond that angle — another surface is generated, smaller, or equal to, or larger than the first.

48.

OF DRAWING OUTLINE.

Consider with the greatest care the form of the outlines of every object, and the character of their undulations. And these undulations must be separately studied, as to whether the curves are composed of arched convexities or angular concavities.

49.

The nature of the outline.

The boundaries of bodies are the least of all things. The proposition is proved to be true, because the boundary of a thing is a surface, which is not part of the body contained within that surface; nor is it part of the air surrounding that body, but is the medium interposed between the air and the body, as is proved in its place. But the lateral boundaries of these bodies is the line forming the boundary of the surface, which line is of invisible thickness. Wherefore O painter! do not surround your bodies with lines, and above all when representing objects smaller than nature; for not only will their external outlines become indistinct, but their parts will be invisible from distance.

50.

Definition of Perspective.

[Drawing is based upon perspective, which is nothing else than a thorough knowledge of the function of the eye. And this function simply consists in receiving in a pyramid the forms and colours of all the objects placed before it. I say in a pyramid, because there is no object so small that it will not be larger than the spot where these pyramids are received into the eye. Therefore, if you extend the lines from the edges of each body as they converge you will bring them to a single point, and necessarily the said lines must form a pyramid.]

[Perspective is nothing more than a rational demonstration applied to the consideration of how objects in front of the eye transmit their image to it, by means of a pyramid of lines. The *Pyramid* is the name I apply to the lines which, starting from the surface and edges of each object, converge from a distance and meet in a single point.]

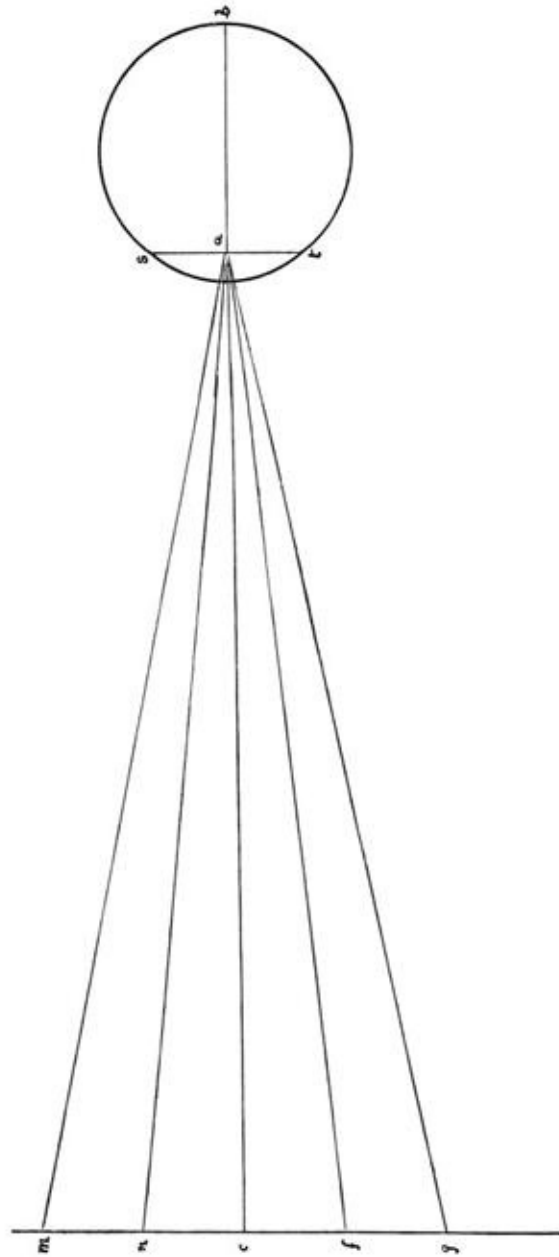
[Perspective is a rational demonstration, by which we may practically and clearly understand how objects transmit their own image, by lines forming a Pyramid (centred) in the eye.]

Perspective is a rational demonstration by which experience confirms that every object sends its image to the eye by a pyramid of lines; and bodies of equal size will result in a pyramid of larger or smaller size, according to the difference in their distance, one from the other. By a pyramid of lines I mean those which start from the surface and edges of bodies, and, converging from a distance meet in a single point. A point is said to be that which [having no dimensions] cannot be divided, and this point placed in the eye receives all the points of the cone.

[Footnote: 50. 1-5. Compare with this the Proem. No. 21. The paragraphs placed in brackets: lines 1-9, 10-14, and 17 — 20, are evidently mere sketches and, as such, were cancelled by the writer; but they serve as a commentary on the final paragraph, lines 22-29.]

51.

IN WHAT WAY THE EYE SEES OBJECTS PLACED IN FRONT OF IT.



The perception of the object depends on the direction of the eye.

Supposing that the ball figured above is the ball of the eye and let the small portion of the ball which is cut off by the line *s t* be the pupil and all the objects mirrored on the centre of the face of the eye, by means of the pupil, pass on at once and enter the pupil, passing through the crystalline humour, which does not interfere in the pupil with the things seen by means of the light. And the pupil having received the objects, by means of the light, immediately refers them and transmits them to the intellect by the line *a b*. And you must know that the pupil transmits nothing perfectly to the intellect or common sense excepting when the objects presented to it by means of light, reach it by the line *a b*; as, for instance,

by the line $b c$. For although the lines $m n$ and $f g$ may be seen by the pupil they are not perfectly taken in, because they do not coincide with the line $a b$. And the proof is this: If the eye, shown above, wants to count the letters placed in front, the eye will be obliged to turn from letter to letter, because it cannot discern them unless they lie in the line $a b$; as, for instance, in the line $a c$. All visible objects reach the eye by the lines of a pyramid, and the point of the pyramid is the apex and centre of it, in the centre of the pupil, as figured above.

[Footnote: 51. In this problem the eye is conceived of as fixed and immovable; this is plain from line 11.]

Experimental proof of the existence of the pyramid of sight (52-55).

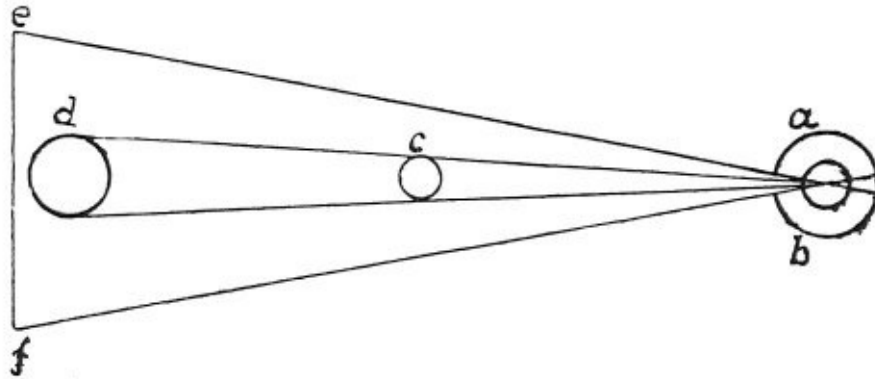
52.

Perspective is a rational demonstration, confirmed by experience, that all objects transmit their image to the eye by a pyramid of lines.

By a pyramid of lines I understand those lines which start from the edges of the surface of bodies, and converging from a distance, meet in a single point; and this point, in the present instance, I will show to be situated in the eye which is the universal judge of all objects. By a point I mean that which cannot be divided into parts; therefore this point, which is situated in the eye, being indivisible, no body is seen by the eye, that is not larger than this point. This being the case it is inevitable that the lines which come from the object to the point must form a pyramid. And if any man seeks to prove that the sense of sight does not reside in this point, but rather in the black spot which is visible in the middle of the pupil, I might reply to him that a small object could never diminish at any distance, as it might be a grain of millet or of oats or of some similar thing, and that object, if it were larger than the said [black] spot would never be seen as a whole; as may be seen in the diagram below. Let a .



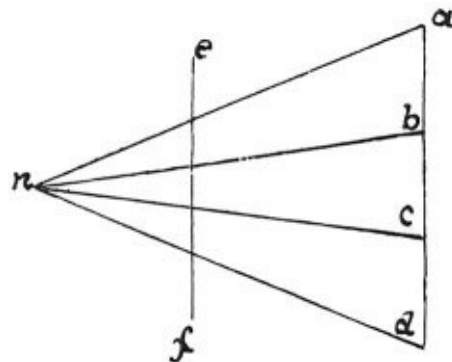
be the seat of sight, $b e$ the lines which reach the eye.



Let $e d$ be the grains of millet within these lines. You plainly see that these will never diminish by distance, and that the body $m n$ could not be entirely covered by it. Therefore you must confess that the eye contains within itself one single indivisible point a , to which all the points converge of the pyramid of lines starting from an object, as is shown below. Let $a. b.$ be the eye; in the centre of it is the point above mentioned. If the line $e f$ is to enter as an image into so small an opening in the eye, you must confess that the smaller object cannot enter into what is smaller than itself unless it is diminished, and by diminishing it must take the form of a pyramid.

53.

PERSPECTIVE.



Perspective comes in where judgment fails [as to the distance] in objects which diminish. The eye can never be a true judge for determining with exactitude how near one object is to another which is equal to it [in size], if the top of that other is on the level of the eye which sees them on that side, excepting by means of the vertical plane which is the standard and guide of perspective. Let n be the eye, $e f$ the vertical plane above mentioned. Let $a b c d$ be the three divisions, one

below the other; if the lines $a n$ and $c n$ are of a given length and the eye n is in the centre, then $a b$ will look as large as $b c$. $c d$ is lower and farther off from n , therefore it will look smaller. And the same effect will appear in the three divisions of a face when the eye of the painter who is drawing it is on a level with the eye of the person he is painting.

54.

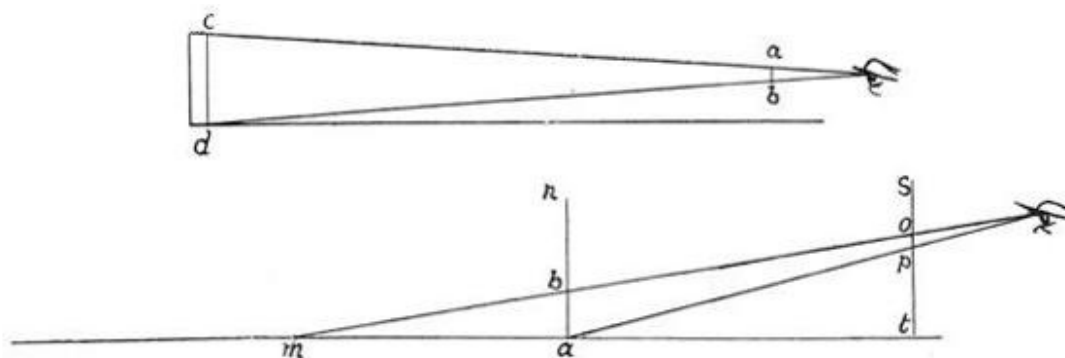
TO PROVE HOW OBJECTS REACH THE EYE.

If you look at the sun or some other luminous body and then shut your eyes you will see it again inside your eye for a long time. This is evidence that images enter into the eye.

The relations of the distance points to the vanishing point (55-56).

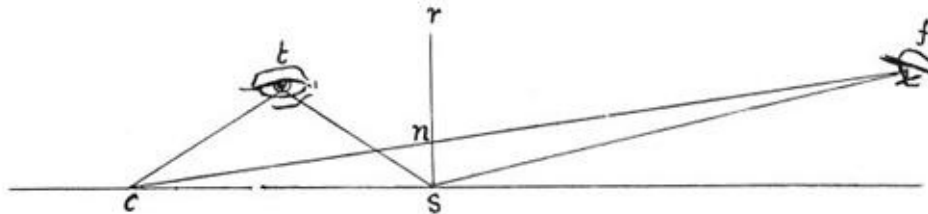
55.

ELEMENTS OF PERSPECTIVE.



All objects transmit their image to the eye in pyramids, and the nearer to the eye these pyramids are intersected the smaller will the image appear of the objects which cause them. Therefore, you may intersect the pyramid with a vertical plane [Footnote 4: *Pariete*. Compare the definitions in 85, 2-5, 6-27. These lines refer exclusively to the third diagram. For the better understanding of this it should be observed that $c s$ must be regarded as representing the section or profile of a square plane, placed horizontally (comp. lines 11, 14, 17) for which

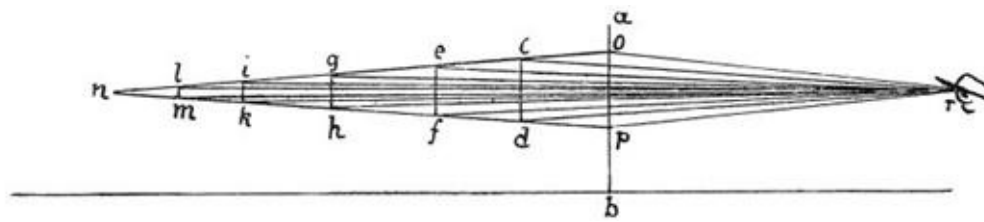
the word *pianura* is subsequently employed (20, 22). Lines 6-13 contain certain preliminary observations to guide the reader in understanding the diagram; the last three seem to have been added as a supplement. Leonardo's mistake in writing *t denota* (line 6) for *f denota* has been rectified.] which reaches the base of the pyramid as is shown in the plane *a n*.



The eye *f* and the eye *t* are one and the same thing; but the eye *f* marks the distance, that is to say how far you are standing from the object; and the eye *t* shows you the direction of it; that is whether you are opposite, or on one side, or at an angle to the object you are looking at. And remember that the eye *f* and the eye *t* must always be kept on the same level. For example if you raise or lower the eye from the distance point *f* you must do the same with the direction point *t*. And if the point *f* shows how far the eye is distant from the square plane but does not show on which side it is placed — and, if in the same way, the point *t* shows the direction and not the distance, in order to ascertain both you must use both points and they will be one and the same thing. If the eye *f* could see a perfect square of which all the sides were equal to the distance between *s* and *c*, and if at the nearest end of the side towards the eye a pole were placed, or some other straight object, set up by a perpendicular line as shown at *r s* — then, I say, that if you were to look at the side of the square that is nearest to you it will appear at the bottom of the vertical plane *r s*, and then look at the farther side and it would appear to you at the height of the point *n* on the vertical plane. Thus, by this example, you can understand that if the eye is above a number of objects all placed on the same level, one beyond another, the more remote they are the higher they will seem, up to the level of the eye, but no higher; because objects placed upon the level on which your feet stand, so long as it is flat — even if it be extended into infinity — would never be seen above the eye; since the eye has in itself the point towards which all the cones tend and converge which convey the images of the objects to the eye. And this point always coincides with the point of diminution which is the extreme of all we can see. And from the base line of the first pyramid as far as the diminishing point

[Footnote: The two diagrams above the chapter are explained by the first five lines. They have, however, more letters than are referred to in the text, a circumstance we frequently find occasion to remark.]

56.



there are only bases without pyramids which constantly diminish up to this point. And from the first base where the vertical plane is placed towards the point in the eye there will be only pyramids without bases; as shown in the example given above. Now, let ab be the said vertical plane and r the point of the pyramid terminating in the eye, and n the point of diminution which is always in a straight line opposite the eye and always moves as the eye moves — just as when a rod is moved its shadow moves, and moves with it, precisely as the shadow moves with a body. And each point is the apex of a pyramid, all having a common base with the intervening vertical plane. But although their bases are equal their angles are not equal, because the diminishing point is the termination of a smaller angle than that of the eye. If you ask me: “By what practical experience can you show me these points?” I reply — so far as concerns the diminishing point which moves with you — when you walk by a ploughed field look at the straight furrows which come down with their ends to the path where you are walking, and you will see that each pair of furrows will look as though they tried to get nearer and meet at the [farther] end.

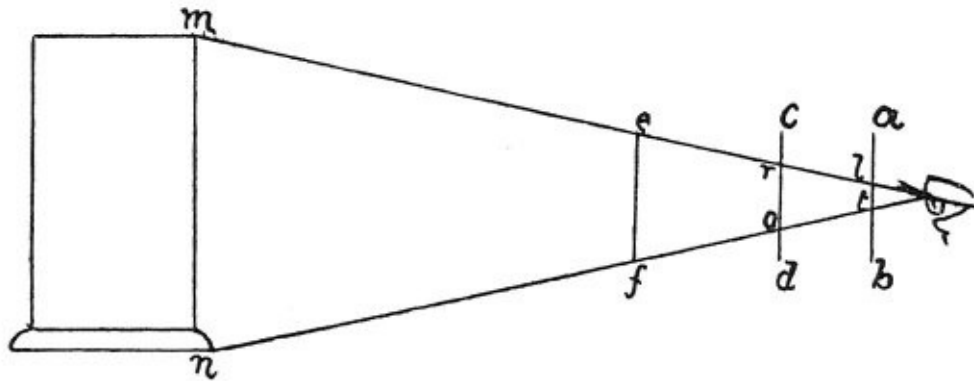
[Footnote: For the easier understanding of the diagram and of its connection with the preceding I may here remark that the square plane shown above in profile by the line cs is here indicated by $edop$. According to lines 1, 3 ab must be imagined as a plane of glass placed perpendicularly at op .]

57.

How to measure the pyramid of vision.

As regards the point in the eye; it is made more intelligible by this: If you look into the eye of another person you will see your own image. Now imagine 2 lines starting from your ears and going to the ears of that image which you see in the other man’s eye; you will understand that these lines converge in such a way that they would meet in a point a little way beyond your own image mirrored in the eye. And if you want to measure the diminution of the pyramid in the air

which occupies the space between the object seen and the eye, you must do it according to the diagram figured below. Let $m n$ be a tower, and $e f$ a rod, which you must move backwards and forwards till its ends correspond with those of the tower [Footnote 9: *I sua stremi .. della storre* (its ends ... of the tower) this is the case at $e f$.]; then bring it nearer to the eye, at $c d$ and you will see that the image of the tower seems smaller, as at $r o$. Then [again] bring it closer to the eye and you will see the rod project far beyond the image of the tower from a to b and from t to b , and so you will discern that, a little farther within, the lines must converge in a point.



The Production of pyramid of Vision (58-60).

58.

PERSPECTIVE.

The instant the atmosphere is illuminated it will be filled with an infinite number of images which are produced by the various bodies and colours assembled in it. And the eye is the target, a loadstone, of these images.

59.

The whole surface of opaque bodies displays its whole image in all the illuminated atmosphere which surrounds them on all sides.

60.

That the atmosphere attracts to itself, like a loadstone, all the images of the objects that exist in it, and not their forms merely but their nature may be clearly seen by the sun, which is a hot and luminous body. All the atmosphere, which is the all-pervading matter, absorbs light and heat, and reflects in itself the image of the source of that heat and splendour and, in each minutest portion, does the same. The Northpole does the same as the loadstone shows; and the moon and the other planets, without suffering any diminution, do the same. Among terrestrial things musk does the same and other perfumes.

61.

All bodies together, and each by itself, give off to the surrounding air an infinite number of images which are all-pervading and each complete, each conveying the nature, colour and form of the body which produces it.

It can clearly be shown that all bodies are, by their images, all-pervading in the surrounding atmosphere, and each complete in itself as to substance form and colour; this is seen by the images of the various bodies which are reproduced in one single perforation through which they transmit the objects by lines which intersect and cause reversed pyramids, from the objects, so that they are upside down on the dark plane where they are first reflected. The reason of this is —

[Footnote: The diagram intended to illustrate the statement (Pl. II No. i) occurs in the original between lines 3 and 4. The three circles must be understood to represent three luminous bodies which transmit their images through perforations in a wall into a dark chamber, according to a law which is more fully explained in 75?81. So far as concerns the present passage the diagram is only intended to explain that the images of the three bodies may be made to coalesce at any given spot. In the circles are written, giallo — yellow, biàcho — white, rosso — red.

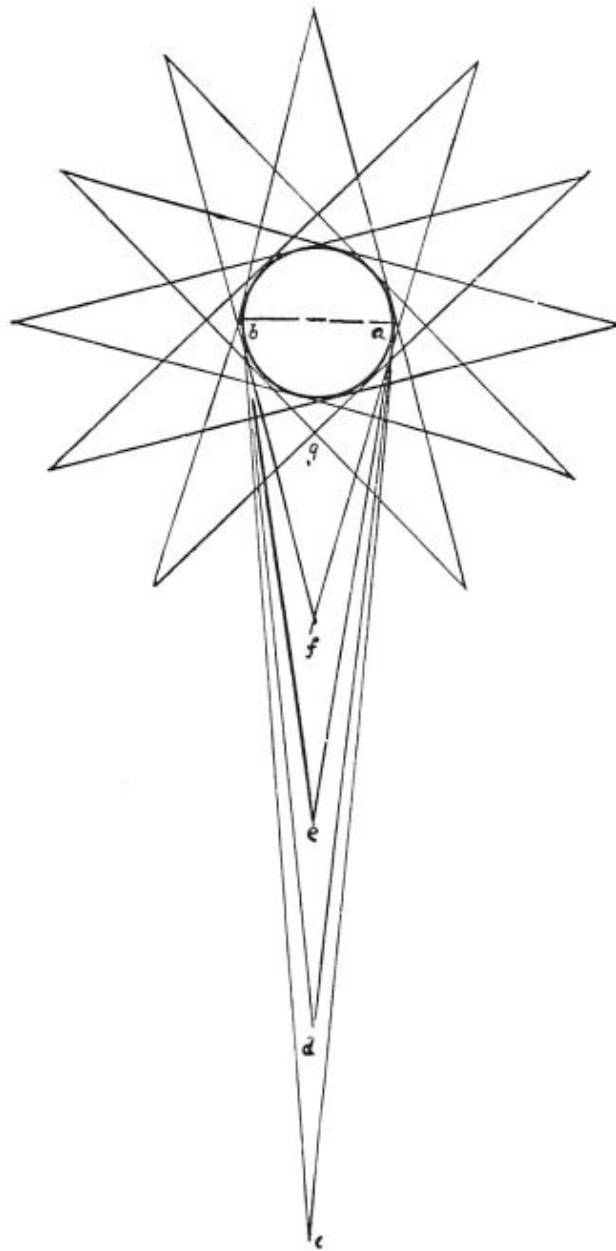
The text breaks off at line 8. The paragraph No.40 follows here in the original MS.]

62.

Every point is the termination of an infinite number of lines, which diverge to form a base, and immediately, from the base the same lines converge to a pyramid [imaging] both the colour and form. No sooner is a form created or compounded than suddenly infinite lines and angles are produced from it; and

these lines, distributing themselves and intersecting each other in the air, give rise to an infinite number of angles opposite to each other. Given a base, each opposite angle, will form a triangle having a form and proportion equal to the larger angle; and if the base goes twice into each of the 2 lines of the pyramid the smaller triangle will do the same.

63.



Every body in light and shade fills the surrounding air with infinite images of

itself; and these, by infinite pyramids diffused in the air, represent this body throughout space and on every side. Each pyramid that is composed of a long assemblage of rays includes within itself an infinite number of pyramids and each has the same power as all, and all as each. A circle of equidistant pyramids of vision will give to their object angles of equal size; and an eye at each point will see the object of the same size. The body of the atmosphere is full of infinite pyramids composed of radiating straight lines, which are produced from the surface of the bodies in light and shade, existing in the air; and the farther they are from the object which produces them the more acute they become and although in their distribution they intersect and cross they never mingle together, but pass through all the surrounding air, independently converging, spreading, and diffused. And they are all of equal power [and value]; all equal to each, and each equal to all. By these the images of objects are transmitted through all space and in every direction, and each pyramid, in itself, includes, in each minutest part, the whole form of the body causing it.

64.

The body of the atmosphere is full of infinite radiating pyramids produced by the objects existing in it. These intersect and cross each other with independent convergence without interfering with each other and pass through all the surrounding atmosphere; and are of equal force and value — all being equal to each, each to all. And by means of these, images of the body are transmitted everywhere and on all sides, and each receives in itself every minutest portion of the object that produces it.

Proof by experiment (65-66).

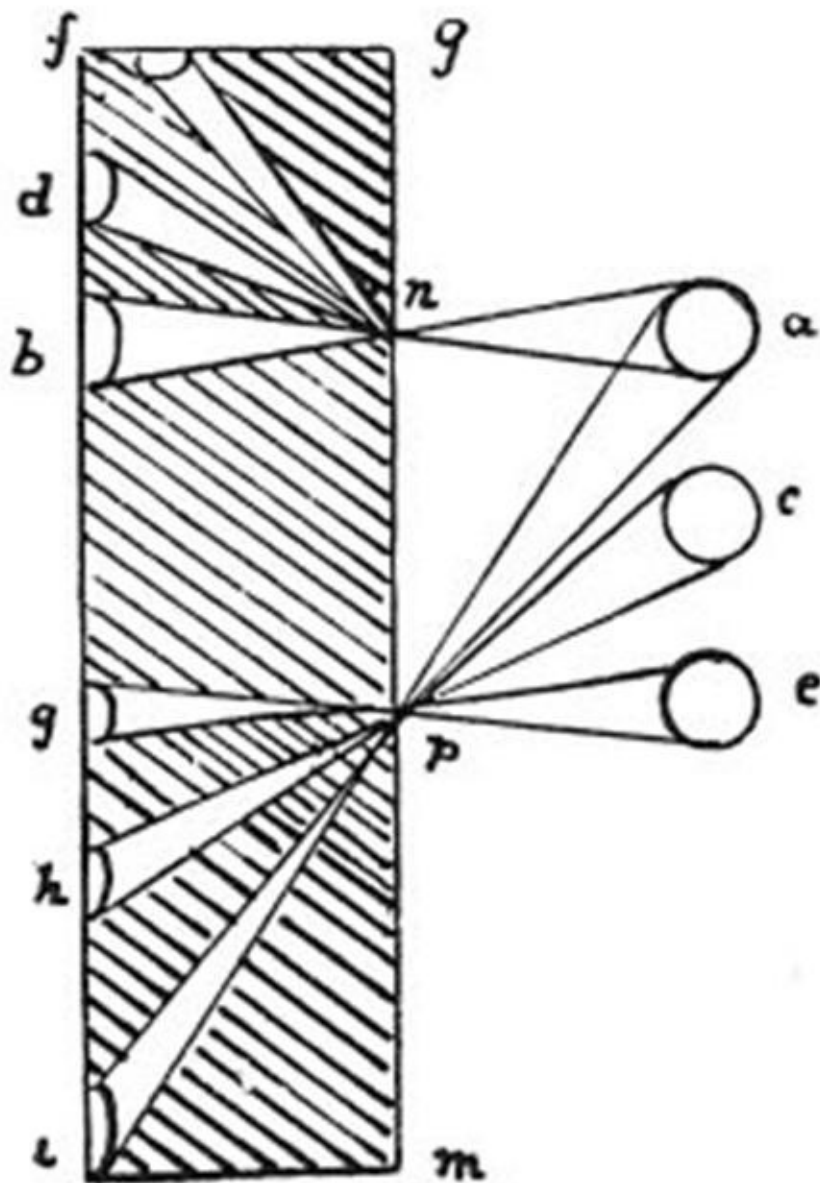
65.

PERSPECTIVE.

The air is filled with endless images of the objects distributed in it; and all are represented in all, and all in one, and all in each, whence it happens that if two mirrors are placed in such a manner as to face each other exactly, the first will be reflected in the second and the second in the first. The first being reflected in the

second takes to it the image of itself with all the images represented in it, among which is the image of the second mirror, and so, image within image, they go on to infinity in such a manner as that each mirror has within it a mirror, each smaller than the last and one inside the other. Thus, by this example, it is clearly proved that every object sends its image to every spot whence the object itself can be seen; and the converse: That the same object may receive in itself all the images of the objects that are in front of it. Hence the eye transmits through the atmosphere its own image to all the objects that are in front of it and receives them into itself, that is to say on its surface, whence they are taken in by the common sense, which considers them and if they are pleasing commits them to the memory. Whence I am of opinion: That the invisible images in the eyes are produced towards the object, as the image of the object to the eye. That the images of the objects must be disseminated through the air. An instance may be seen in several mirrors placed in a circle, which will reflect each other endlessly. When one has reached the other it is returned to the object that produced it, and thence — being diminished — it is returned again to the object and then comes back once more, and this happens endlessly. If you put a light between two flat mirrors with a distance of 1 braccio between them you will see in each of them an infinite number of lights, one smaller than another, to the last. If at night you put a light between the walls of a room, all the parts of that wall will be tinted with the image of that light. And they will receive the light and the light will fall on them, mutually, that is to say, when there is no obstacle to interrupt the transmission of the images. This same example is seen in a greater degree in the distribution of the solar rays which all together, and each by itself, convey to the object the image of the body which causes it. That each body by itself alone fills with its images the atmosphere around it, and that the same air is able, at the same time, to receive the images of the endless other objects which are in it, this is clearly proved by these examples. And every object is everywhere visible in the whole of the atmosphere, and the whole in every smallest part of it; and all the objects in the whole, and all in each smallest part; each in all and all in every part.

66.



The images of objects are all diffused through the atmosphere which receives them; and all on every side in it. To prove this, let $a c e$ be objects of which the images are admitted to a dark chamber by the small holes $n p$ and thrown upon the plane $f i$ opposite to these holes. As many images will be produced in the chamber on the plane as the number of the said holes.

67.

General conclusions.

All objects project their whole image and likeness, diffused and mingled in the whole of the atmosphere, opposite to themselves. The image of every point of the bodily surface, exists in every part of the atmosphere. All the images of the objects are in every part of the atmosphere. The whole, and each part of the image of the atmosphere is [reflected] in each point of the surface of the bodies presented to it. Therefore both the part and the whole of the images of the objects exist, both in the whole and in the parts of the surface of these visible bodies. Whence we may evidently say that the image of each object exists, as a whole and in every part, in each part and in the whole interchangeably in every existing body. As is seen in two mirrors placed opposite to each other.

68.

That the contrary is impossible.

It is impossible that the eye should project from itself, by visual rays, the visual virtue, since, as soon as it opens, that front portion [of the eye] which would give rise to this emanation would have to go forth to the object and this it could not do without time. And this being so, it could not travel so high as the sun in a month's time when the eye wanted to see it. And if it could reach the sun it would necessarily follow that it should perpetually remain in a continuous line from the eye to the sun and should always diverge in such a way as to form between the sun and the eye the base and the apex of a pyramid. This being the case, if the eye consisted of a million worlds, it would not prevent its being consumed in the projection of its virtue; and if this virtue would have to travel through the air as perfumes do, the winds would bent it and carry it into another place. But we do [in fact] see the mass of the sun with the same rapidity as [an object] at the distance of a braccio, and the power of sight is not disturbed by the blowing of the winds nor by any other accident.

[Footnote: The view here refuted by Leonardo was maintained among others by Bramantino, Leonardo's Milanese contemporary. LOMAZZO writes as follows in his *Trattato dell' Arte della pittura* &c. (Milano 1584. Libr. V cp. XXI): Sovviemmi di aver già letto in certi scritti alcune cose di Bramantino milanese, celebratissimo pittore, attenente alla prospettiva, le quali ho voluto riferire, e quasi intessere in questo luogo, affinché sappiamo qual fosse l'opinione di così chiaro e famoso pittore intorno alla prospettiva . . . Scrive Bramantino che la prospettiva è una cosa che contrafa il naturale, e che ciò si fa in tre modi

Circa il primo modo che si fa con ragione, per essere la cosa in poche parole

conclusa da Bramantino in maniera che giudico non potersi dir meglio, contenendovi si tutta Parte del principio al fine, io riferirò per appunto le proprie parole sue (cp. XXII, Prima prospettiva di Bramantino). La prima prospettiva fa le cose di punto, e l'altra non mai, e la terza più appresso. Adunque la prima si dimanda prospettiva, cioè ragione, la quale fa l'effetto dell' occhio, facendo crescere e calare secondo gli effetti degli occhi. Questo crescere e calare non procede della cosa propria, che in se per esser lontana, ovvero vicina, per quello effetto non può crescere e sminuire, ma procede dagli effetti degli occhi, i quali sono piccioli, e perciò volendo vedere tanto gran cosa, bisogna che mandino fuori la virtù visiva, *la quale si dilata in tanta larghezza, che piglia tutto quello che vuoi vedere, ed arrivando a quella cosa la vede dove è: e da lei agli occhi per quello circuito fino all' occhio, e tutto quello termine è pieno di quella cosa.*

It is worthy of note that Leonardo had made his memorandum refuting this view, at Milan in 1492]

69.

A parallel case.

Just as a stone flung into the water becomes the centre and cause of many circles, and as sound diffuses itself in circles in the air: so any object, placed in the luminous atmosphere, diffuses itself in circles, and fills the surrounding air with infinite images of itself. And is repeated, the whole everywhere, and the whole in every smallest part. This can be proved by experiment, since if you shut a window that faces west and make a hole [Footnote: 6. Here the text breaks off.] . .

[Footnote: Compare LIBRI, *Histoire des sciences mathématiques en Italie*. Tome III, p. 43.]

The function of the eye as explained by the camera obscura (70. 71).

70.

If the object in front of the eye sends its image to the eye, the eye, on the other hand, sends its image to the object, and no portion whatever of the object is lost in the images it throws off, for any reason either in the eye or the object. Therefore we may rather believe it to be the nature and potency of our luminous atmosphere which absorbs the images of the objects existing in it, than the nature of the objects, to send their images through the air. If the object opposite to the

eye were to send its image to the eye, the eye would have to do the same to the object, whence it might seem that these images were an emanation. But, if so, it would be necessary [to admit] that every object became rapidly smaller; because each object appears by its images in the surrounding atmosphere. That is: the whole object in the whole atmosphere, and in each part; and all the objects in the whole atmosphere and all of them in each part; speaking of that atmosphere which is able to contain in itself the straight and radiating lines of the images projected by the objects. From this it seems necessary to admit that it is in the nature of the atmosphere, which subsists between the objects, and which attracts the images of things to itself like a loadstone, being placed between them.

PROVE HOW ALL OBJECTS, PLACED IN ONE POSITION, ARE ALL EVERYWHERE AND ALL IN EACH PART.

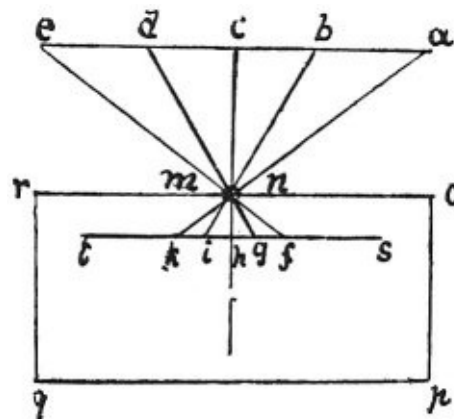
I say that if the front of a building — or any open piazza or field — which is illuminated by the sun has a dwelling opposite to it, and if, in the front which does not face the sun, you make a small round hole, all the illuminated objects will project their images through that hole and be visible inside the dwelling on the opposite wall which may be made white; and there, in fact, they will be upside down, and if you make similar openings in several places in the same wall you will have the same result from each. Hence the images of the illuminated objects are all everywhere on this wall and all in each minutest part of it. The reason, as we clearly know, is that this hole must admit some light to the said dwelling, and the light admitted by it is derived from one or many luminous bodies. If these bodies are of various colours and shapes the rays forming the images are of various colours and shapes, and so will the representations be on the wall.

[Footnote: 70. 15 — 23. This section has already been published in the *“Saggio delle Opere di Leonardo da Vinci”* Milan 1872, pp. 13, 14. G. Govi observes upon it, that Leonardo is not to be regarded as the inventor of the Camera obscura, but that he was the first to explain by it the structure of the eye. An account of the Camera obscura first occurs in CESARE CESARINI's Italian version of Vitruvius, pub. 1523, four years after Leonardo's death. Cesarini expressly names Benedettino Don Papnutio as the inventor of the Camera obscura. In his explanation of the function of the eye by a comparison with the

Camera obscura Leonardo was the precursor of G. CARDANO, Professor of Medicine at Bologna (died 1576) and it appears highly probable that this is, in fact, the very discovery which Leonardo ascribes to himself in section 21 without giving any further details.]

71.

HOW THE IMAGES OF OBJECTS RECEIVED BY THE EYE INTERSECT WITHIN THE CRYSTALLINE HUMOUR OF THE EYE.



An experiment, showing how objects transmit their images or pictures, intersecting within the eye in the crystalline humour, is seen when by some small round hole penetrate the images of illuminated objects into a very dark chamber. Then, receive these images on a white paper placed within this dark room and rather near to the hole and you will see all the objects on the paper in their proper forms and colours, but much smaller; and they will be upside down by reason of that very intersection. These images being transmitted from a place illuminated by the sun will seem actually painted on this paper which must be extremely thin and looked at from behind. And let the little perforation be made in a very thin plate of iron. Let *a b e d e* be the object illuminated by the sun and *o r* the front of the dark chamber in which is the said hole at *n m*. Let *s t* be the sheet of paper intercepting the rays of the images of these objects upside down, because the rays being straight, *a* on the right hand becomes *k* on the left, and *e* on the left becomes *f* on the right; and the same takes place inside the pupil.

[Footnote: This chapter is already known through a translation into French by

VENTURI. Compare his '*Essai sur les ouvrages physico-mathématiques de L. da Vinci avec des fragments tirés de ses Manuscrits, apportés de l'Italie. Lu a la premiere classe de l'Institut national des Sciences et Arts.*' Paris, An V (1797).]

The practice of perspective (72. 73).

72.

In the practice of perspective the same rules apply to light and to the eye.

73.

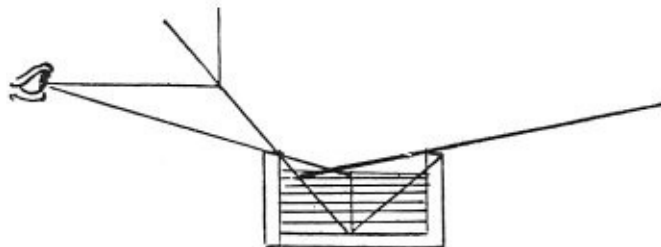
The object which is opposite to the pupil of the eye is seen by that pupil and that which is opposite to the eye is seen by the pupil.

Refraction of the rays falling upon the eye (74. 75)

74.

The lines sent forth by the image of an object to the eye do not reach the point within the eye in straight lines.

75.



If the judgment of the eye is situated within it, the straight lines of the images are refracted on its surface because they pass through the rarer to the denser medium. If, when you are under water, you look at objects in the air you will see them out of their true place; and the same with objects under water seen from the air.

The intersection of the rays (76-82).

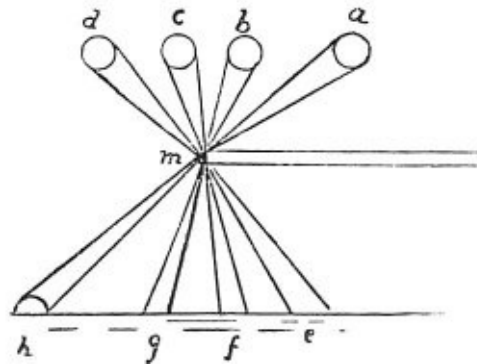
76.

The inversion of the images.

All the images of objects which pass through a window [glass pane] from the free outer air to the air confined within walls, are seen on the opposite side; and an object which moves in the outer air from east to west will seem in its shadow, on the wall which is lighted by this confined air, to have an opposite motion.

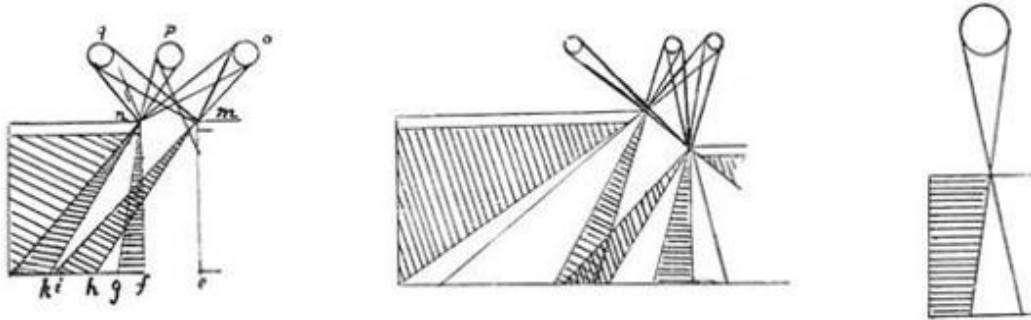
77.

THE PRINCIPLE ON WHICH THE IMAGES OF BODIES PASS IN BETWEEN THE MARGINS OF THE OPENINGS BY WHICH THEY ENTER.



What difference is there in the way in which images pass through narrow openings and through large openings, or in those which pass by the sides of shaded bodies? By moving the edges of the opening through which the images are admitted, the images of immovable objects are made to move. And this happens, as is shown in the 9th which demonstrates: [Footnote 11: *per la 9a che dicie*. When Leonardo refers thus to a number it serves to indicate marginal diagrams; this can in some instances be distinctly proved. The ninth sketch on the page W. L. 145 b corresponds to the middle sketch of the three reproduced.] the images of any object are all everywhere, and all in each part of the surrounding air. It follows that if one of the edges of the hole by which the images are admitted to a dark chamber is moved it cuts off those rays of the image that were in contact with it and gets nearer to other rays which previously were remote from it &c.

OF THE MOVEMENT OF THE EDGE AT THE RIGHT OR LEFT, OR THE UPPER, OR LOWER EDGE.



If you move the right side of the opening the image on the left will move [being that] of the object which entered on the right side of the opening; and the same result will happen with all the other sides of the opening. This can be proved by the 2nd of this which shows: all the rays which convey the images of objects through the air are straight lines. Hence, if the images of very large bodies have to pass through very small holes, and beyond these holes recover their large size, the lines must necessarily intersect.

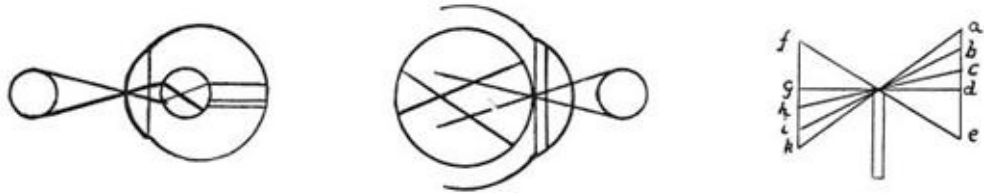
[Footnote: 77. 2. In the first of the three diagrams Leonardo had drawn only one of the two margins, et *m.*]

78.



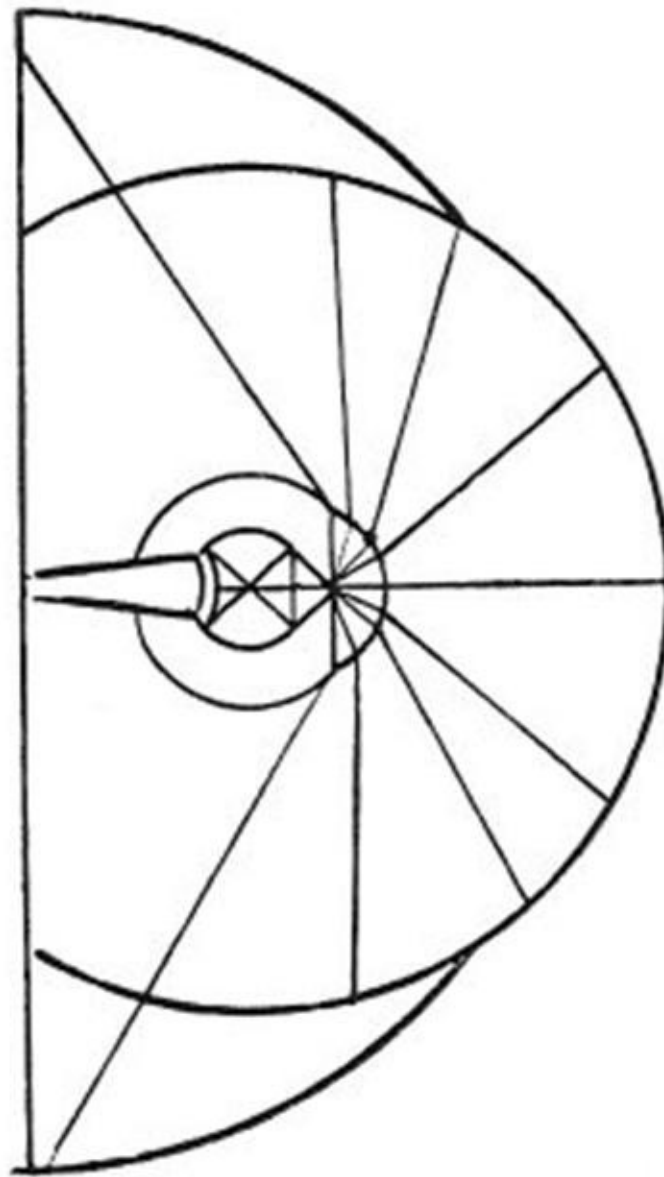
Necessity has provided that all the images of objects in front of the eye shall intersect in two places. One of these intersections is in the pupil, the other in the crystalline lens; and if this were not the case the eye could not see so great a number of objects as it does. This can be proved, since all the lines which intersect do so in a point. Because nothing is seen of objects excepting their surface; and their edges are lines, in contradistinction to the definition of a surface. And each minute part of a line is equal to a point; for *smallest* is said of that than which nothing can be smaller, and this definition is equivalent to the definition of the point. Hence it is possible for the whole circumference of a

circle to transmit its image to the point of intersection, as is shown in the 4th of this which shows: all the smallest parts of the images cross each other without interfering with each other. These demonstrations are to illustrate the eye. No image, even of the smallest object, enters the eye without being turned upside down; but as it penetrates into the crystalline lens it is once more reversed and thus the image is restored to the same position within the eye as that of the object outside the eye.



79.

OF THE CENTRAL LINE OF THE EYE.

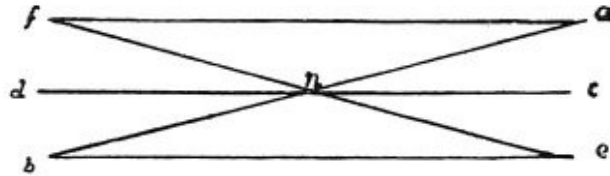


Only one line of the image, of all those that reach the visual virtue, has no intersection; and this has no sensible dimensions because it is a mathematical line which originates from a mathematical point, which has no dimensions.

According to my adversary, necessity requires that the central line of every image that enters by small and narrow openings into a dark chamber shall be turned upside down, together with the images of the bodies that surround it.

80.

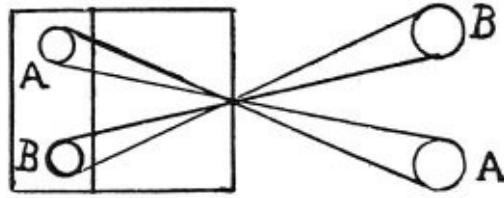
AS TO WHETHER THE CENTRAL LINE OF THE IMAGE CAN BE INTERSECTED, OR NOT, WITHIN THE OPENING.



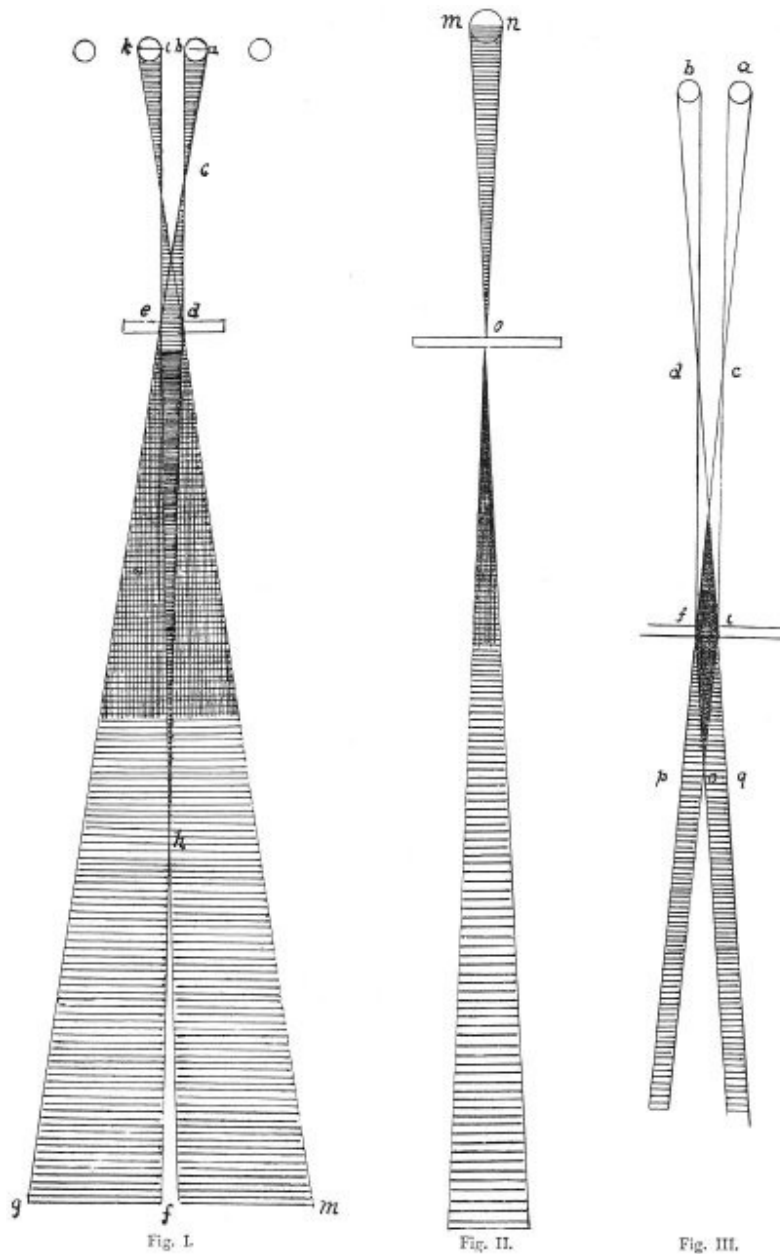
It is impossible that the line should intersect itself; that is, that its right should cross over to its left side, and so, its left side become its right side. Because such an intersection demands two lines, one from each side; for there can be no motion from right to left or from left to right in itself without such extension and thickness as admit of such motion. And if there is extension it is no longer a line but a surface, and we are investigating the properties of a line, and not of a surface. And as the line, having no centre of thickness cannot be divided, we must conclude that the line can have no sides to intersect each other. This is proved by the movement of the line af to ab and of the line eb to ef , which are the sides of the surface $afeb$. But if you move the line ab and the line ef , with the frontends ae , to the spot c , you will have moved the opposite ends fb towards each other at the point d . And from the two lines you will have drawn the straight line cd which cuts the middle of the intersection of these two lines at the point n without any intersection. For, you imagine these two lines as having breadth, it is evident that by this motion the first will entirely cover the other — being equal with it — without any intersection, in the position cd . And this is sufficient to prove our proposition.

81.

HOW THE INNUMERABLE RAYS FROM INNUMERABLE IMAGES CAN CONVERGE TO A POINT.



Just as all lines can meet at a point without interfering with each other — being without breadth or thickness — in the same way all the images of surfaces can meet there; and as each given point faces the object opposite to it and each object faces an opposite point, the converging rays of the image can pass through the point and diverge again beyond it to reproduce and re-magnify the real size of that image. But their impressions will appear reversed — as is shown in the first, above; where it is said that every image intersects as it enters the narrow openings made in a very thin substance.



Read the marginal text on the other side.

In proportion as the opening is smaller than the shaded body, so much less will the images transmitted through this opening intersect each other. The sides of images which pass through openings into a dark room intersect at a point which is nearer to the opening in proportion as the opening is narrower. To prove this let *a b* be an object in light and shade which sends not its shadow but the image of its darkened form through the opening *d e* which is as wide as this shaded body; and its sides *a b*, being straight lines (as has been proved) must intersect between the shaded object and the opening; but nearer to the opening in proportion as it is smaller than the object in shade. As is shown, on your right

hand and your left hand, in the two diagrams *a b c n m o* where, the right opening *d e*, being equal in width to the shaded object *a b*, the intersection of the sides of the said shaded object occurs half way between the opening and the shaded object at the point *c*. But this cannot happen in the left hand figure, the opening *o* being much smaller than the shaded object *n m*.

It is impossible that the images of objects should be seen between the objects and the openings through which the images of these bodies are admitted; and this is plain, because where the atmosphere is illuminated these images are not formed visibly.

When the images are made double by mutually crossing each other they are invariably doubly as dark in tone. To prove this let *d e h* be such a doubling which although it is only seen within the space between the bodies in *b* and *i* this will not hinder its being seen from *f g* or from *f m*; being composed of the images *a b i k* which run together in *d e h*.

[Footnote: 81. On the original diagram at the beginning of this chapter Leonardo has written “*azurro*” (blue) where in the facsimile I have marked *A*, and “*giallo*” (yellow) where *B* stands.]

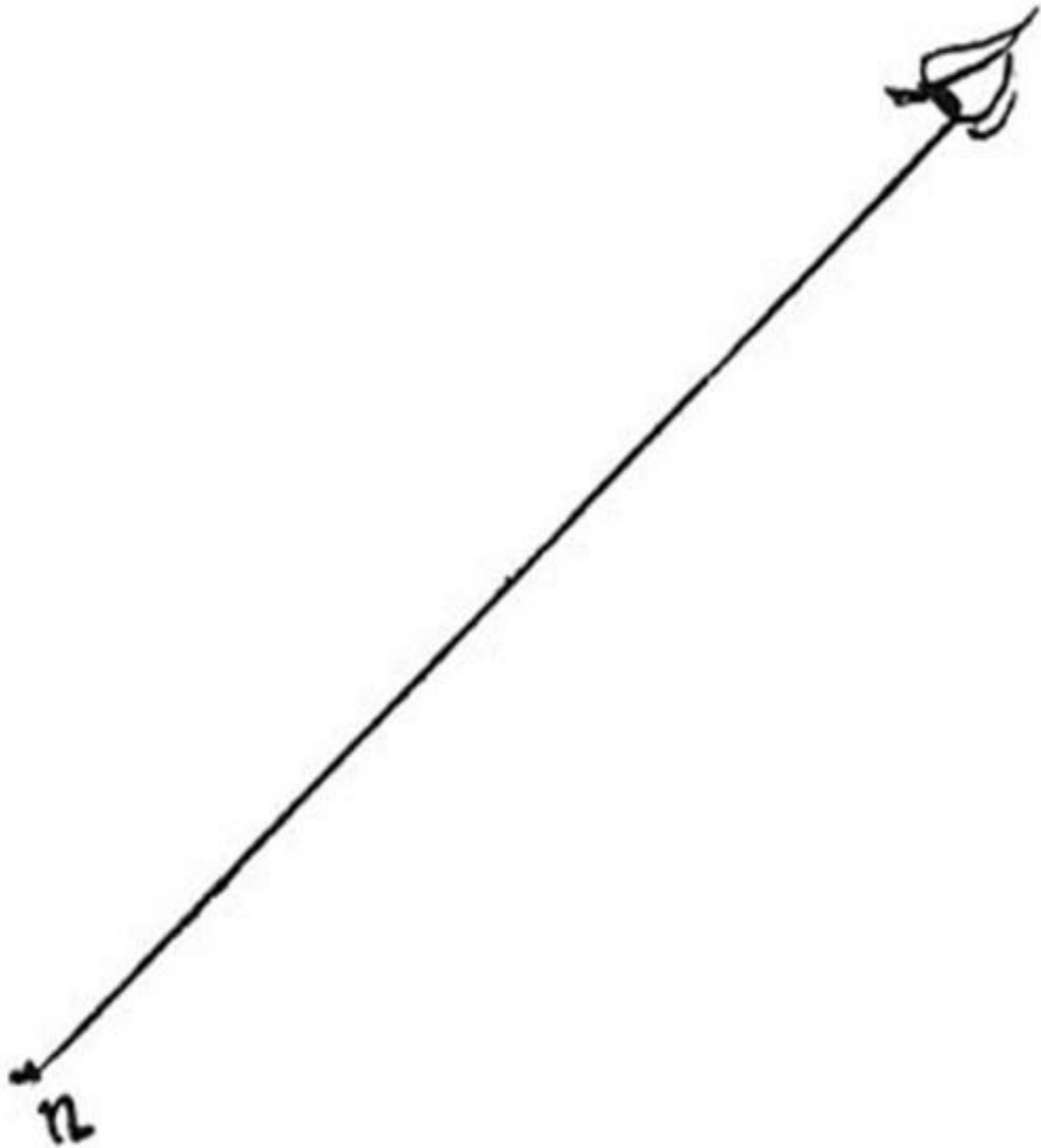
[Footnote: 15 — 23. These lines stand between the diagrams I and III.]

[Footnote: 24 — 53. These lines stand between the diagrams I and II.]

[Footnote: 54 — 97 are written along the left side of diagram I.]

82.

An experiment showing that though the pupil may not be moved from its position the objects seen by it may appear to move from their places.



If you look at an object at some distance from you and which is below the eye, and fix both your eyes upon it and with one hand firmly hold the upper lid open while with the other you push up the under lid — still keeping your eyes fixed on the object gazed at — you will see that object double; one [image] remaining steady, and the other moving in a contrary direction to the pressure of your finger on the lower eyelid. How false the opinion is of those who say that this happens because the pupil of the eye is displaced from its position.

How the above mentioned facts prove that the pupil acts upside down in seeing.

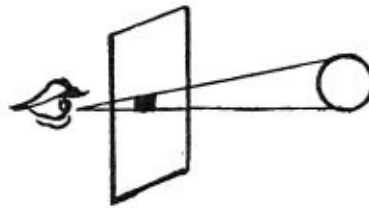
[Footnote: 82. 14 — 17. The subject indicated by these two headings is fully

discussed in the two chapters that follow them in the original; but it did not seem to me appropriate to include them here.]

Demonstration of perspective by means of a vertical glass plane (83-85).

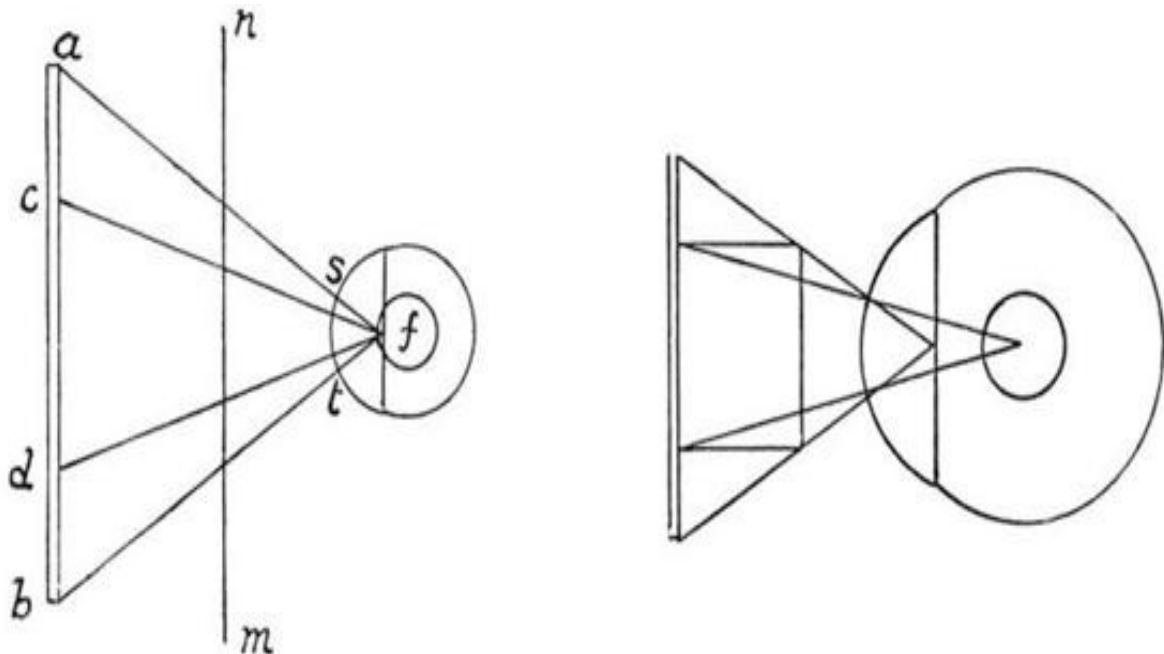
83.

OF THE PLANE OF GLASS.



Perspective is nothing else than seeing place [or objects] behind a plane of glass, quite transparent, on the surface of which the objects behind that glass are to be drawn. These can be traced in pyramids to the point in the eye, and these pyramids are intersected on the glass plane.

84.

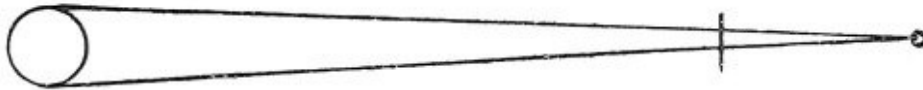


Pictorial perspective can never make an object at the same distance, look of

the same size as it appears to the eye. You see that the apex of the pyramid $f c d$ is as far from the object $c d$ as the same point f is from the object $a b$; and yet $c d$, which is the base made by the painter's point, is smaller than $a b$ which is the base of the lines from the objects converging in the eye and refracted at $s t$, the surface of the eye. This may be proved by experiment, by the lines of vision and then by the lines of the painter's plumbline by cutting the real lines of vision on one and the same plane and measuring on it one and the same object.

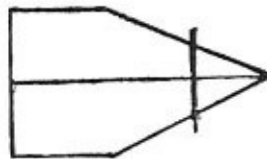
85.

PERSPECTIVE.



The vertical plane is a perpendicular line, imagined as in front of the central point where the apex of the pyramids converge. And this plane bears the same relation to this point as a plane of glass would, through which you might see the various objects and draw them on it. And the objects thus drawn would be smaller than the originals, in proportion as the distance between the glass and the eye was smaller than that between the glass and the objects.

PERSPECTIVE.



The different converging pyramids produced by the objects, will show, on the plane, the various sizes and remoteness of the objects causing them.

PERSPECTIVE.

All those horizontal planes of which the extremes are met by perpendicular lines forming right angles, if they are of equal width the more they rise to the level of eye the less this is seen, and the more the eye is above them the more will their

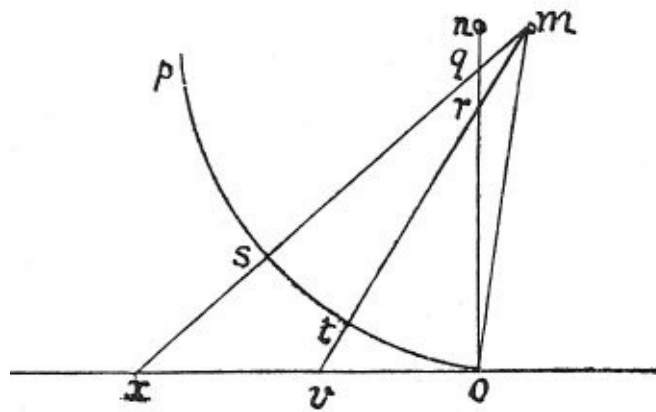
real width be seen.

PERSPECTIVE.

The farther a spherical body is from the eye the more you will see of it.

The angle of sight varies with the distance (86-88)

86.



A simple and natural method; showing how objects appear to the eye without any other medium.

The object that is nearest to the eye always seems larger than another of the same size at greater distance. The eye *m*, seeing the spaces *o v x*, hardly detects the difference between them, and the reason of this is that it is close to them [Footnote 6: It is quite inconceivable to me why M. RAVAISSON, in a note to his French translation of this simple passage should have remarked: *Il est clair que c'est par erreur que Leonard a écrit per esser visino au lieu de per non esser visino.* (See his printed ed. of MS. A. p. 38.)]; but if these spaces are marked on the vertical plane *n o* the space *o v* will be seen at *o r*, and in the same way the space *v x* will appear at *r q*. And if you carry this out in any place where you can walk round, it will look out of proportion by reason of the great difference in the spaces *o r* and *r q*. And this proceeds from the eye being so much below [near] the plane that the plane is foreshortened. Hence, if you wanted to carry it out, you would have [to arrange] to see the perspective through a single hole which must be at the point *m*, or else you must go to a distance of at least 3 times the height of the object you see. The plane *o p* being always equally remote from the eye will reproduce the objects in a satisfactory way, so that they may be seen

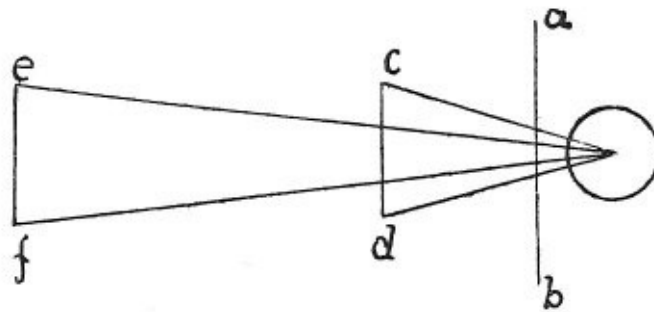
from place to place.

87.

How every large mass sends forth its images, which may diminish through infinity.

The images of any large mass being infinitely divisible may be infinitely diminished.

88.



Objects of equal size, situated in various places, will be seen by different pyramids which will each be smaller in proportion as the object is farther off.

89.

Perspective, in dealing with distances, makes use of two opposite pyramids, one of which has its apex in the eye and the base as distant as the horizon. The other has the base towards the eye and the apex on the horizon. Now, the first includes the [visible] universe, embracing all the mass of the objects that lie in front of the eye; as it might be a vast landscape seen through a very small opening; for the more remote the objects are from the eye, the greater number can be seen through the opening, and thus the pyramid is constructed with the base on the horizon and the apex in the eye, as has been said. The second pyramid is extended to a spot which is smaller in proportion as it is farther from the eye; and this second perspective [= pyramid] results from the first.

90.

SIMPLE PERSPECTIVE.

Simple perspective is that which is constructed by art on a vertical plane which is equally distant from the eye in every part. Complex perspective is that which is constructed on a ground-plan in which none of the parts are equally distant from the eye.

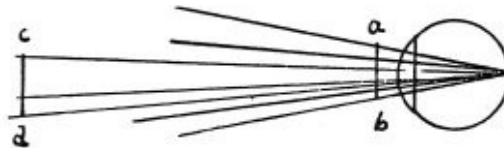
91.

PERSPECTIVE.

No surface can be seen exactly as it is, if the eye that sees it is not equally remote from all its edges.

92.

WHY WHEN AN OBJECT IS PLACED CLOSE TO THE EYE ITS EDGES ARE INDISTINCT.



When an object opposite the eye is brought too close to it, its edges must become too confused to be distinguished; as it happens with objects close to a light, which cast a large and indistinct shadow, so is it with an eye which estimates objects opposite to it; in all cases of linear perspective, the eye acts in the same way as the light. And the reason is that the eye has one leading line (of vision) which dilates with distance and embraces with true discernment large objects at

a distance as well as small ones that are close. But since the eye sends out a multitude of lines which surround this chief central one and since these which are farthest from the centre in this cone of lines are less able to discern with accuracy, it follows that an object brought close to the eye is not at a due distance, but is too near for the central line to be able to discern the outlines of the object. So the edges fall within the lines of weaker discerning power, and these are to the function of the eye like dogs in the chase which can put up the game but cannot take it. Thus these cannot take in the objects, but induce the central line of sight to turn upon them, when they have put them up. Hence the objects which are seen with these lines of sight have confused outlines.

The relative size of objects with regard to their distance from the eye (93-98).

93.

PERSPECTIVE.

Small objects close at hand and large ones at a distance, being seen within equal angles, will appear of the same size.

94.

PERSPECTIVE.



There is no object so large but that at a great distance from the eye it does not appear smaller than a smaller object near.

95.

Among objects of equal size that which is most remote from the eye will look

the smallest. [Footnote: This axiom, sufficiently clear in itself, is in the original illustrated by a very large diagram, constructed like that here reproduced under No. 108.

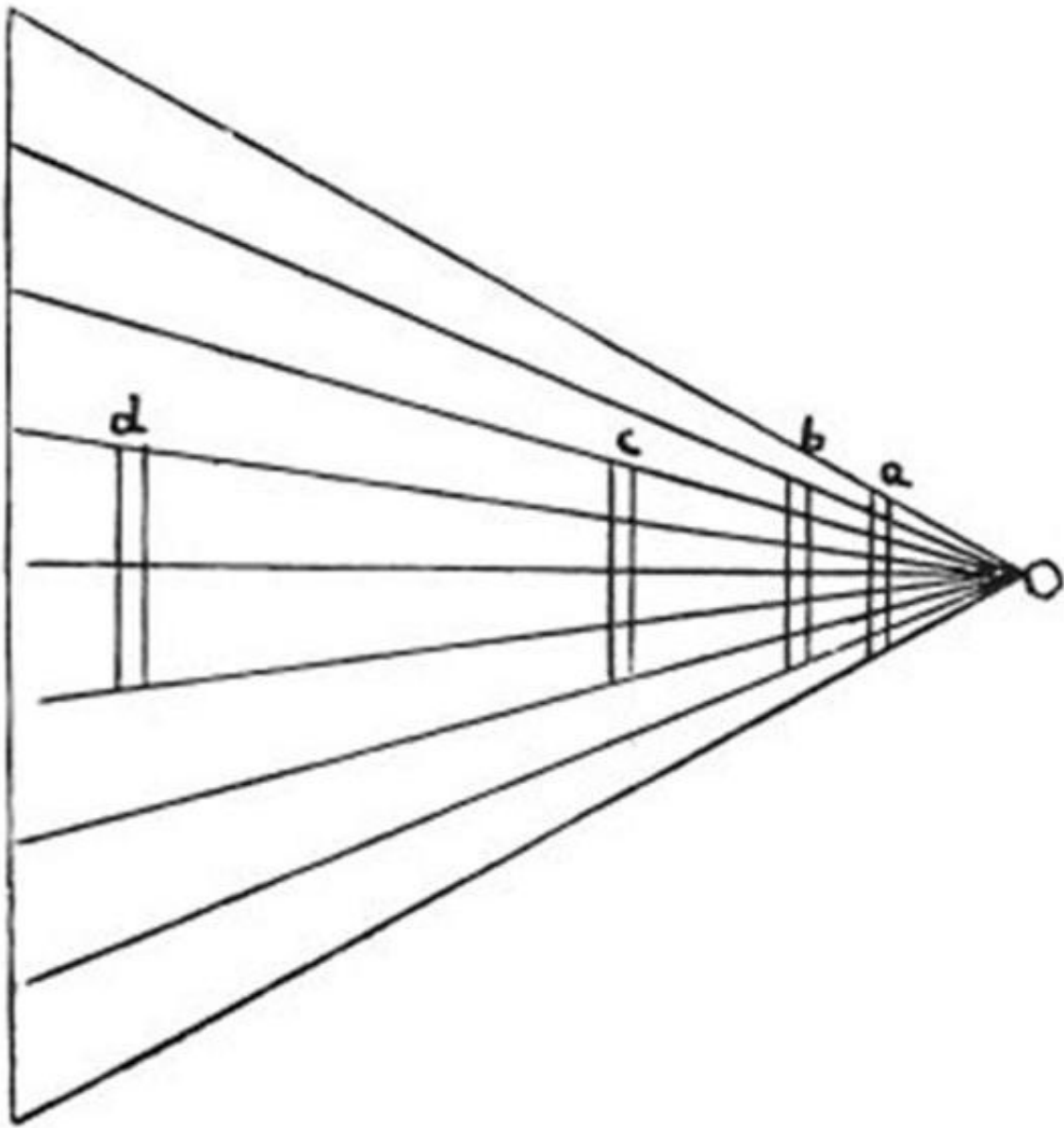
The same idea is repeated in C. A. I a; I a, stated as follows: *Infra le cose d'equal grandezza quella si dimostra di minor figura che sara più distante dall'occhio. —]*

96.

Why an object is less distinct when brought near to the eye, and why with spectacles, or without the naked eye sees badly either close or far off [as the case may be].

97.

PERSPECTIVE.



Among objects of equal size, that which is most remote from the eye will look the smallest.

98.

PERSPECTIVE.

No second object can be so much lower than the first as that the eye will not see it higher than the first, if the eye is above the second.

PERSPECTIVE.

And this second object will never be so much higher than the first as that the eye, being below them, will not see the second as lower than the first.

PERSPECTIVE.

If the eye sees a second square through the centre of a smaller one, that is nearer, the second, larger square will appear to be surrounded by the smaller one.

PERSPECTIVE — PROPOSITION.

Objects that are farther off can never be so large but that those in front, though smaller, will conceal or surround them.

DEFINITION.

This proposition can be proved by experiment. For if you look through a small hole there is nothing so large that it cannot be seen through it and the object so seen appears surrounded and enclosed by the outline of the sides of the hole. And if you stop it up, this small stopping will conceal the view of the largest object.

The apparent size of objects defined by calculation (99-105)

99.

OF LINEAR PERSPECTIVE.

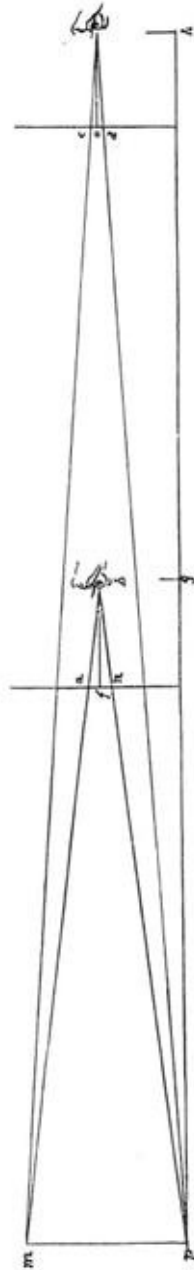
Linear Perspective deals with the action of the lines of sight, in proving by

measurement how much smaller is a second object than the first, and how much the third is smaller than the second; and so on by degrees to the end of things visible. I find by experience that if a second object is as far beyond the first as the first is from the eye, although they are of the same size, the second will seem half the size of the first and if the third object is of the same size as the 2nd, and the 3rd is as far beyond the second as the 2nd from the first, it will appear of half the size of the second; and so on by degrees, at equal distances, the next farthest will be half the size of the former object. So long as the space does not exceed the length of 20 braccia. But, beyond 20 braccia figures of equal size will lose $\frac{2}{4}$ and at 40 braccia they will lose $\frac{9}{10}$, and $\frac{19}{20}$ at 60 braccia, and so on diminishing by degrees. This is if the picture plane is distant from you twice your own height. If it is only as far off as your own height, there will be a great difference between the first braccia and the second.

[Footnote: This chapter is included in DUFRESNE'S and MANZI'S editions of the Treatise on Painting. H. LUDWIG, in his commentary, calls this chapter "*eines der wichtigsten im ganzen Tractat*", but at the same time he asserts that its substance has been so completely disfigured in the best MS. copies that we ought not to regard Leonardo as responsible for it. However, in the case of this chapter, the old MS. copies agree with the original as it is reproduced above. From the chapters given later in this edition, which were written at a subsequent date, it would appear that Leonardo corrected himself on these points.]

100.

OF THE DIMINUTION OF OBJECTS AT VARIOUS DISTANCES.



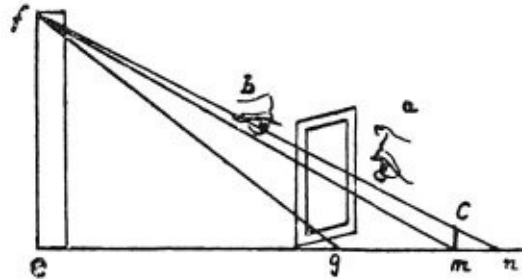
A second object as far distant from the first as the first is from the eye will appear half the size of the first, though they be of the same size really.

OF THE DEGREES OF DIMINUTION.

If you place the vertical plane at one braccio from the eye, the first object, being at a distance of 4 braccia from your eye will diminish to $\frac{3}{4}$ of its height at that plane; and if it is 8 braccia from the eye, to $\frac{7}{8}$; and if it is 16 braccia off, it will diminish to $\frac{15}{16}$ of its height and so on by degrees, as the space doubles the

diminution will double.

101.



If an goes 3 times into fb , mp will do the same into pg . Then go backwards so far as that cd goes twice into an and pg will be equal to gh . And mp will go into hp as often as dc into op .

[Footnote: The first three lines are unfortunately very obscure.]

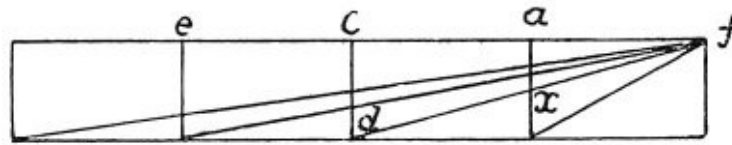
102.

I GIVE THE DEGREES OF THE OBJECTS SEEN BY THE EYE AS THE MUSICIAN DOES THE NOTES HEARD BY THE EAR.

Although the objects seen by the eye do, in fact, touch each other as they recede, I will nevertheless found my rule on spaces of 20 braccia each; as a musician does with notes, which, though they can be carried on one into the next, he divides into degrees from note to note calling them 1st, 2nd, 3rd, 4th, 5th; and has affixed a name to each degree in raising or lowering the voice.

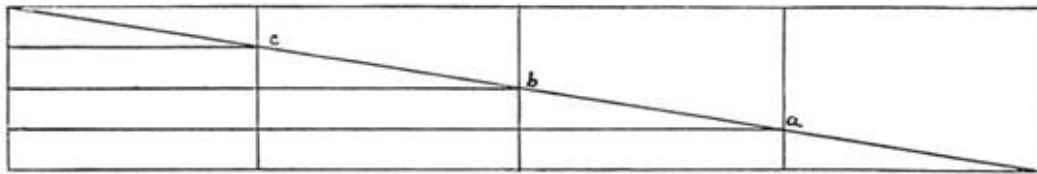
103.

PERSPECTIVE.



Let f be the level and distance of the eye; and a the vertical plane, as high as a man; let e be a man, then I say that on the plane this will be the distance from the plane to the 2nd man.

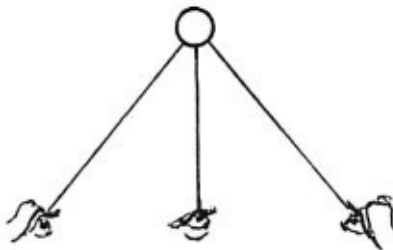
104.



The differences in the diminution of objects of equal size in consequence of their various remoteness from the eye will bear among themselves the same proportions as those of the spaces between the eye and the different objects. Find out how much a man diminishes at a certain distance and what its length is; and then at twice that distance and at 3 times, and so make your general rule.

105.

The eye cannot judge where an object high up ought to descend.

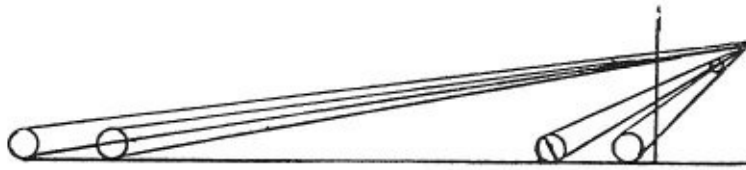


106.

PERSPECTIVE.

If two similar and equal objects are placed one beyond the other at a given distance the difference in their size will appear greater in proportion as they are nearer to the eye that sees them. And conversely there will seem to be less difference in their size in proportion as they are remote from the eye.

This is proved by the proportions of their distances among themselves; for, if the first of these two objects were as far from the eye, as the 2nd from the first this would be called the second proportion: since, if the first is at 1 braccia from the eye and the 2nd at two braccia, two being twice as much as one, the first object will look twice as large as the second. But if you place the first at a hundred braccia from you and the second at a hundred and one, you will find that the first is only so much larger than the second as 100 is less than 101; and the converse is equally true. And again, the same thing is proved by the 4th of this book which shows that among objects that are equal, there is the same proportion in the diminution of the size as in the increase in the distance from the eye of the spectator.



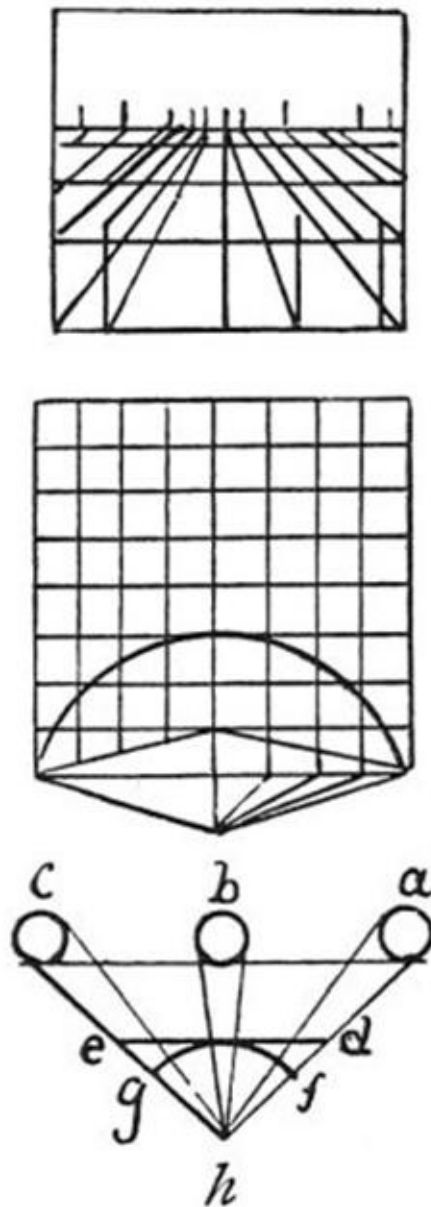
On natural perspective (107 — 109).

107.

OF EQUAL OBJECTS THE MOST REMOTE LOOK THE SMALLEST.

The practice of perspective may be divided into ... parts [Footnote 4: *in ... parte*. The space for the number is left blank in the original.], of which the first

treats of objects seen by the eye at any distance; and it shows all these objects just as the eye sees them diminished, without obliging a man to stand in one place rather than another so long as the plane does not produce a second foreshortening.

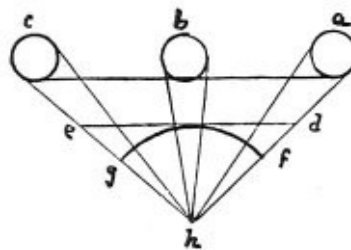


But the second practice is a combination of perspective derived partly from art and partly from nature and the work done by its rules is in every portion of it, influenced by natural perspective and artificial perspective. By natural perspective I mean that the plane on which this perspective is represented is a flat surface, and this plane, although it is parallel both in length and height, is forced to diminish in its remoter parts more than in its nearer ones. And this is

proved by the first of what has been said above, and its diminution is natural. But artificial perspective, that is that which is devised by art, does the contrary; for objects equal in size increase on the plane where it is foreshortened in proportion as the eye is more natural and nearer to the plane, and as the part of the plane on which it is figured is farther from the eye.

And let this plane be *d e* on which are seen 3 equal circles which are beyond this plane *d e*, that is the circles *a b c*. Now you see that the eye *h* sees on the vertical plane the sections of the images, largest of those that are farthest and smallest of the nearest.

108.



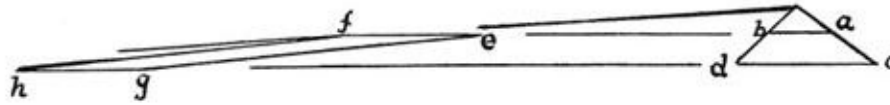
Here follows what is wanting in the margin at the foot on the other side of this page.

Natural perspective acts in a contrary way; for, at greater distances the object seen appears smaller, and at a smaller distance the object appears larger. But this said invention requires the spectator to stand with his eye at a small hole and then, at that small hole, it will be very plain. But since many (men's) eyes endeavour at the same time to see one and the same picture produced by this artifice only one can see clearly the effect of this perspective and all the others will see confusion. It is well therefore to avoid such complex perspective and hold to simple perspective which does not regard planes as foreshortened, but as much as possible in their proper form. This simple perspective, in which the plane intersects the pyramids by which the images are conveyed to the eye at an equal distance from the eye is our constant experience, from the curved form of the pupil of the eye on which the pyramids are intersected at an equal distance from the visual virtue.

[Footnote 24: *la prima di sopra* i. e. the first of the three diagrams which, in the original MS., are placed in the margin at the beginning of this chapter.]

109.

OF A MIXTURE OF NATURAL AND ARTIFICIAL PERSPECTIVE.



This diagram distinguishes natural from artificial perspective. But before proceeding any farther I will define what is natural and what is artificial perspective. Natural perspective says that the more remote of a series of objects of equal size will look the smaller, and conversely, the nearer will look the larger and the apparent size will diminish in proportion to the distance. But in artificial perspective when objects of unequal size are placed at various distances, the smallest is nearer to the eye than the largest and the greatest distance looks as though it were the least of all; and the cause of this is the plane on which the objects are represented; and which is at unequal distances from the eye throughout its length. And this diminution of the plane is natural, but the perspective shown upon it is artificial since it nowhere agrees with the true diminution of the said plane. Whence it follows, that when the eye is somewhat removed from the [station point of the] perspective that it has been gazing at, all the objects represented look monstrous, and this does not occur in natural perspective, which has been defined above. Let us say then, that the square *a b c d* figured above is foreshortened being seen by the eye situated in the centre of the side which is in front. But a mixture of artificial and natural perspective will be seen in this tetragon called *el main* [Footnote 20: *el main* is quite legibly written in the original; the meaning and derivation of the word are equally doubtful.], that is to say *e f g h* which must appear to the eye of the spectator to be equal to *a b c d* so long as the eye remains in its first position between *c* and *d*. And this will be seen to have a good effect, because the natural perspective of the plane will conceal the defects which would [otherwise] seem monstrous.

III. SIX BOOKS ON LIGHT AND SHADE.

Linear Perspective cannot be immediately followed by either the “prospettiva de’ perdimenti” or the “prospettiva de’ colori” or the aerial perspective; since these branches of the subject presuppose a knowledge of the principles of Light and Shade. No apology, therefore, is here needed for placing these immediately after Linear Perspective.

We have various plans suggested by Leonardo for the arrangement of the mass of materials treating of this subject. Among these I have given the preference to a scheme propounded in No. III, because, in all probability, we have here a final and definite purpose expressed. Several authors have expressed it as their opinion that the Paris Manuscript C is a complete and finished treatise on Light and Shade. Certainly, the Principles of Light and Shade form by far the larger portion of this MS. which consists of two separate parts; still, the materials are far from being finally arranged. It is also evident that he here investigates the subject from the point of view of the Physicist rather than from that of the Painter.

The plan of a scheme of arrangement suggested in No. III and adopted by me has been strictly adhered to for the first four Books. For the three last, however, few materials have come down to us; and it must be admitted that these three Books would find a far more appropriate place in a work on Physics than in a treatise on Painting. For this reason I have collected in Book V all the chapters on Reflections, and in Book VI I have put together and arranged all the sections of MS. C that belong to the book on Painting, so far as they relate to Light and Shade, while the sections of the same MS. which treat of the “Prospettiva de’ perdimenti” have, of course, been excluded from the series on Light and Shade.

[Footnote III: This text has already been published with some slight variations in Dozio’s pamphlet *Degli scritti e disegni di Leonardo da Vinci*, Milan 1871, pp. 30 — 31. Dozio did not transcribe it from the original MS. which seems to have remained unknown to him, but from an old copy (MS. H. 227 in the Ambrosian Library).]

GENERAL INTRODUCTION.

Prolegomena.

110.

You must first explain the theory and then the practice. First you must describe the shadows and lights on opaque objects, and then on transparent bodies.

Scheme of the books on Light and shade.

111.

INTRODUCTION.

[Having already treated of the nature of shadows and the way in which they are cast [Footnote 2: *Avendo io tractato*. — We may suppose that he here refers to some particular MS., possibly Paris C.], I will now consider the places on which they fall; and their curvature, obliquity, flatness or, in short, any character I may be able to detect in them.]

Shadow is the obstruction of light. Shadows appear to me to be of supreme importance in perspective, because, without them opaque and solid bodies will be ill defined; that which is contained within their outlines and their boundaries themselves will be ill-understood unless they are shown against a background of a different tone from themselves. And therefore in my first proposition concerning shadow I state that every opaque body is surrounded and its whole surface enveloped in shadow and light. And on this proposition I build up the first Book. Besides this, shadows have in themselves various degrees of darkness, because they are caused by the absence of a variable amount of the luminous rays; and these I call Primary shadows because they are the first, and inseparable from the object to which they belong. And on this I will found my second Book. From these primary shadows there result certain shaded rays which are diffused through the atmosphere and these vary in character according to that of the primary shadows whence they are derived. I shall therefore call these shadows Derived shadows because they are produced by other shadows; and the third Book will treat of these. Again these derived shadows, where they are intercepted by various objects, produce effects as various as the places where they are cast and of this I will treat in the fourth Book. And since all round the derived shadows, where the derived shadows are intercepted, there is always a

space where the light falls and by reflected dispersion is thrown back towards its cause, it meets the original shadow and mingles with it and modifies it somewhat in its nature; and on this I will compose my fifth Book. Besides this, in the sixth Book I will investigate the many and various diversities of reflections resulting from these rays which will modify the original [shadow] by [imparting] some of the various colours from the different objects whence these reflected rays are derived. Again, the seventh Book will treat of the various distances that may exist between the spot where the reflected rays fall and that where they originate, and the various shades of colour which they will acquire in falling on opaque bodies.

Different principles and plans of treatment (112 — 116).

112.

First I will treat of light falling through windows which I will call Restricted [Light] and then I will treat of light in the open country, to which I will give the name of diffused Light. Then I will treat of the light of luminous bodies.

113.

OF PAINTING.

The conditions of shadow and light [as seen] by the eye are 3. Of these the first is when the eye and the light are on the same side of the object seen; the 2nd is when the eye is in front of the object and the light is behind it. The 3rd is when the eye is in front of the object and the light is on one side, in such a way as that a line drawn from the object to the eye and one from the object to the light should form a right angle where they meet.

114.

OF PAINTING.

This is another section: that is, of the nature of a reflection (from) an object placed between the eye and the light under various aspects.

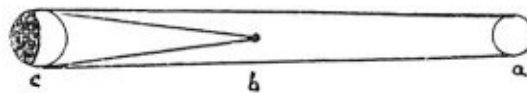
115.

OF PAINTING.



As regards all visible objects 3 things must be considered. These are the position of the eye which sees: that of the object seen [with regard] to the light, and the position of the light which illuminates the object, *b* is the eye, *a* the object seen, *c* the light, *a* is the eye, *b* the illuminating body, *c* is the illuminated object.

116.



Let *a* be the light, *b* the eye, *c* the object seen by the eye and in the light. These show, first, the eye between the light and the body; the 2nd, the light between the eye and the body; the 3rd the body between the eye and the light, *a* is the eye, *b* the illuminated object, *c* the light.



117.

OF PAINTING.

OF THE THREE KINDS OF LIGHT THAT ILLUMINATE OPAQUE BODIES.

The first kind of Light which may illuminate opaque bodies is called Direct light

— as that of the sun or any other light from a window or flame. The second is Diffused [universal] light, such as we see in cloudy weather or in mist and the like. The 3rd is Subdued light, that is when the sun is entirely below the horizon, either in the evening or morning.

118.

OF LIGHT.

The lights which may illuminate opaque bodies are of 4 kinds. These are: diffused light as that of the atmosphere, within our horizon. And Direct, as that of the sun, or of a window or door or other opening. The third is Reflected light; and there is a 4th which is that which passes through [semi] transparent bodies, as linen or paper or the like, but not transparent like glass, or crystal, or other diaphanous bodies, which produce the same effect as though nothing intervened between the shaded object and the light that falls upon it; and this we will discuss fully in our discourse.

Definition of the nature of shadows (119 — 122).

119.

WHAT LIGHT AND SHADOW ARE.

Shadow is the absence of light, merely the obstruction of the luminous rays by an opaque body. Shadow is of the nature of darkness. Light [on an object] is of the nature of a luminous body; one conceals and the other reveals. They are always associated and inseparable from all objects. But shadow is a more powerful agent than light, for it can impede and entirely deprive bodies of their light, while light can never entirely expel shadow from a body, that is from an opaque body.

120.



Shadow is the diminution of light by the intervention of an opaque body. Shadow is the counterpart of the luminous rays which are cut off by an opaque body.

This is proved because the shadow cast is the same in shape and size as the luminous rays were which are transformed into a shadow.

121.

Shadow is the diminution alike of light and of darkness, and stands between darkness and light.

A shadow may be infinitely dark, and also of infinite degrees of absence of darkness.

The beginnings and ends of shadow lie between the light and darkness and may be infinitely diminished and infinitely increased. Shadow is the means by which bodies display their form.

The forms of bodies could not be understood in detail but for shadow.

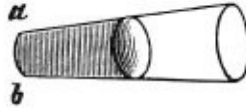
122.

OF THE NATURE OF SHADOW.

Shadow partakes of the nature of universal matter. All such matters are more powerful in their beginning and grow weaker towards the end, I say at the beginning, whatever their form or condition may be and whether visible or invisible. And it is not from small beginnings that they grow to a great size in time; as it might be a great oak which has a feeble beginning from a small acorn. Yet I may say that the oak is most powerful at its beginning, that is where it springs from the earth, which is where it is largest (To return:) Darkness, then, is the strongest degree of shadow and light is its least. Therefore, O Painter, make your shadow darkest close to the object that casts it, and make the end of it fading into light, seeming to have no end.

Of the various kinds of shadows. (123-125).

123.



Darkness is absence of light. Shadow is diminution of light. Primitive shadow is that which is inseparable from a body not in the light. Derived shadow is that which is disengaged from a body in shadow and pervades the air. A cast transparent shadow is that which is surrounded by an illuminated surface. A simple shadow is one which receives no light from the luminous body which causes it. A simple shadow begins within the line which starts from the edge of the luminous body *a b*.

124.

A simple shadow is one where no light at all interferes with it.

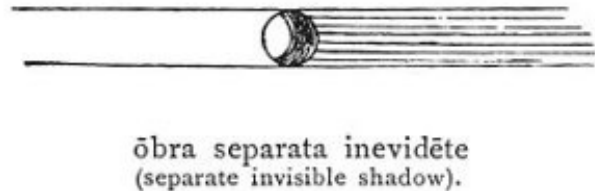
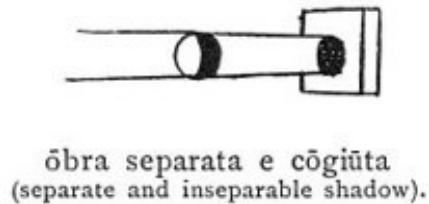
A compound shadow is one which is somewhat illuminated by one or more lights.

125.

WHAT IS THE DIFFERENCE BETWEEN A SHADOW THAT IS INSEPARABLE FROM A BODY AND A CAST SHADOW?

An inseparable shadow is that which is never absent from the illuminated body. As, for instance a ball, which so long as it is in the light always has one side in shadow which never leaves it for any movement or change of position in the ball. A separate shadow may be and may not be produced by the body itself. Suppose the ball to be one braccia distant from a wall with a light on the opposite side of it; this light will throw upon the wall exactly as broad a shadow as is to be seen on the side of the ball that is turned towards the wall. That

portion of the cast shadow will not be visible when the light is below the ball and the shadow is thrown up towards the sky and finding no obstruction on its way is lost.



126.

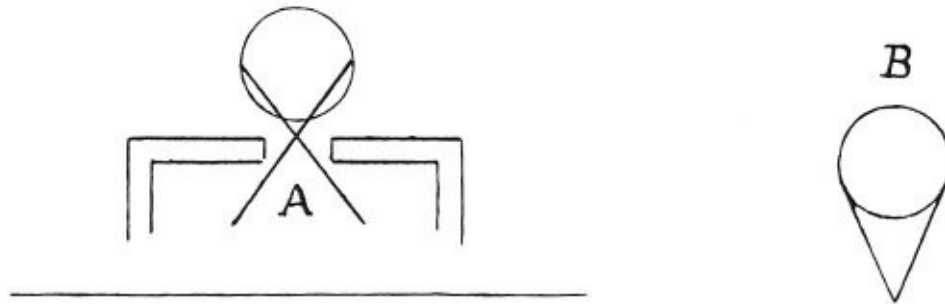
HOW THERE ARE 2 KINDS OF LIGHT, ONE SEPARABLE FROM, AND THE OTHER INSEPARABLE FROM BODIES.

Of the various kinds of light (126, 127).

Separate light is that which falls upon the body. Inseparable light is the side of the body that is illuminated by that light. One is called primary, the other derived. And, in the same way there are two kinds of shadow: — One primary and the other derived. The primary is that which is inseparable from the body, the derived is that which proceeds from the body conveying to the surface of the wall the form of the body causing it.

127.

How there are 2 different kinds of light; one being called diffused, the other restricted. The diffused is that which freely illuminates objects. The restricted is that which being admitted through an opening or window illuminates them on that side only.



[Footnote: At the spot marked *A* in the first diagram Leonardo wrote *lume costretto* (restricted light). At the spot *B* on the second diagram he wrote *lume libero* (diffused light).]

General remarks (128. 129).

128.

Light is the chaser away of darkness. Shade is the obstruction of light. Primary light is that which falls on objects and causes light and shade. And derived lights are those portions of a body which are illuminated by the primary light. A primary shadow is that side of a body on which the light cannot fall.

The general distribution of shadow and light is that sum total of the rays thrown off by a shaded or illuminated body passing through the air without any interference and the spot which intercepts and cuts off the distribution of the dark and light rays.

And the eye can best distinguish the forms of objects when it is placed between the shaded and the illuminated parts.

129.

MEMORANDUM OF THINGS I REQUIRE TO HAVE GRANTED [AS AXIOMS] IN MY EXPLANATION OF PERSPECTIVE.

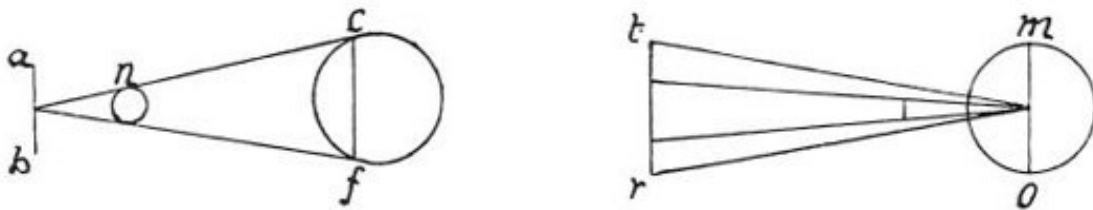
I ask to have this much granted me — to assert that every ray passing through air of equal density throughout, travels in a straight line from its cause to the object

or place it falls upon.

FIRST BOOK ON LIGHT AND SHADE.

On the nature of light (130. 131).

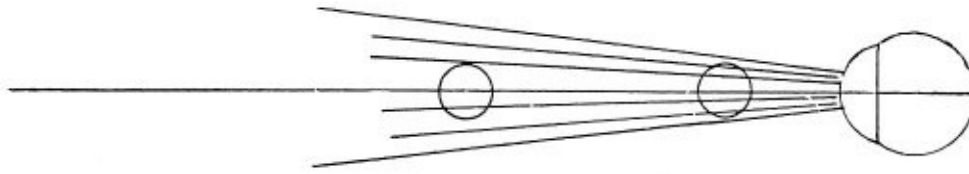
130.



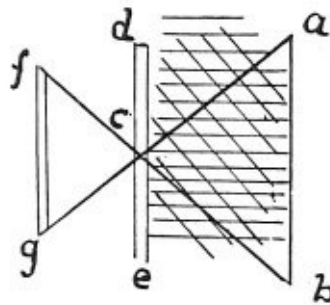
The reason by which we know that a light radiates from a single centre is this: We plainly see that a large light is often much broader than some small object which nevertheless — and although the rays [of the large light] are much more than twice the extent [of the small body] — always has its shadow cast on the nearest surface very visibly. Let cf be a broad light and n be the object in front of it, casting a shadow on the plane, and let ab be the plane. It is clear that it is not the broad light that will cast the shadow n on the plane, but that the light has within it a centre is shown by this experiment. The shadow falls on the plane as is shown at $motr$.

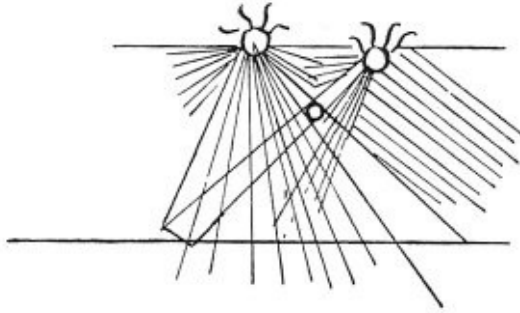
[Footnote 13: In the original MS. no explanatory text is placed after this title-line; but a space is left for it and the text beginning at line 15 comes next.] Why, to two [eyes] or in front of two eyes do 3 objects appear as two?

Why, when you estimate the direction of an object with two sights the nearer appears confused. I say that the eye projects an infinite number of lines which mingle or join those reaching it which come to it from the object looked at. And it is only the central and sensible line that can discern and discriminate colours and objects; all the others are false and illusory. And if you place 2 objects at half an arm's length apart if the nearer of the two is close to the eye its form will remain far more confused than that of the second; the reason is that the first is overcome by a greater number of false lines than the second and so is rendered vague.



Light acts in the same manner, for in the effects of its lines (=rays), and particularly in perspective, it much resembles the eye; and its central rays are what cast the true shadow. When the object in front of it is too quickly overcome with dim rays it will cast a broad and disproportionate shadow, ill defined; but when the object which is to cast the shadow and cuts off the rays near to the place where the shadow falls, then the shadow is distinct; and the more so in proportion as the light is far off, because at a long distance the central ray is less overcome by false rays; because the lines from the eye and the solar and other luminous rays passing through the atmosphere are obliged to travel in straight lines. Unless they are deflected by a denser or rarer air, when they will be bent at some point, but so long as the air is free from grossness or moisture they will preserve their direct course, always carrying the image of the object that intercepts them back to their point of origin. And if this is the eye, the intercepting object will be seen by its colour, as well as by form and size. But if the intercepting plane has in it some small perforation opening into a darker chamber — not darker in colour, but by absence of light — you will see the rays enter through this hole and transmitting to the plane beyond all the details of the object they proceed from both as to colour and form; only every thing will be upside down. But the size [of the image] where the lines are reconstructed will be in proportion to the relative distance of the aperture from the plane on which the lines fall [on one hand] and from their origin [on the other].

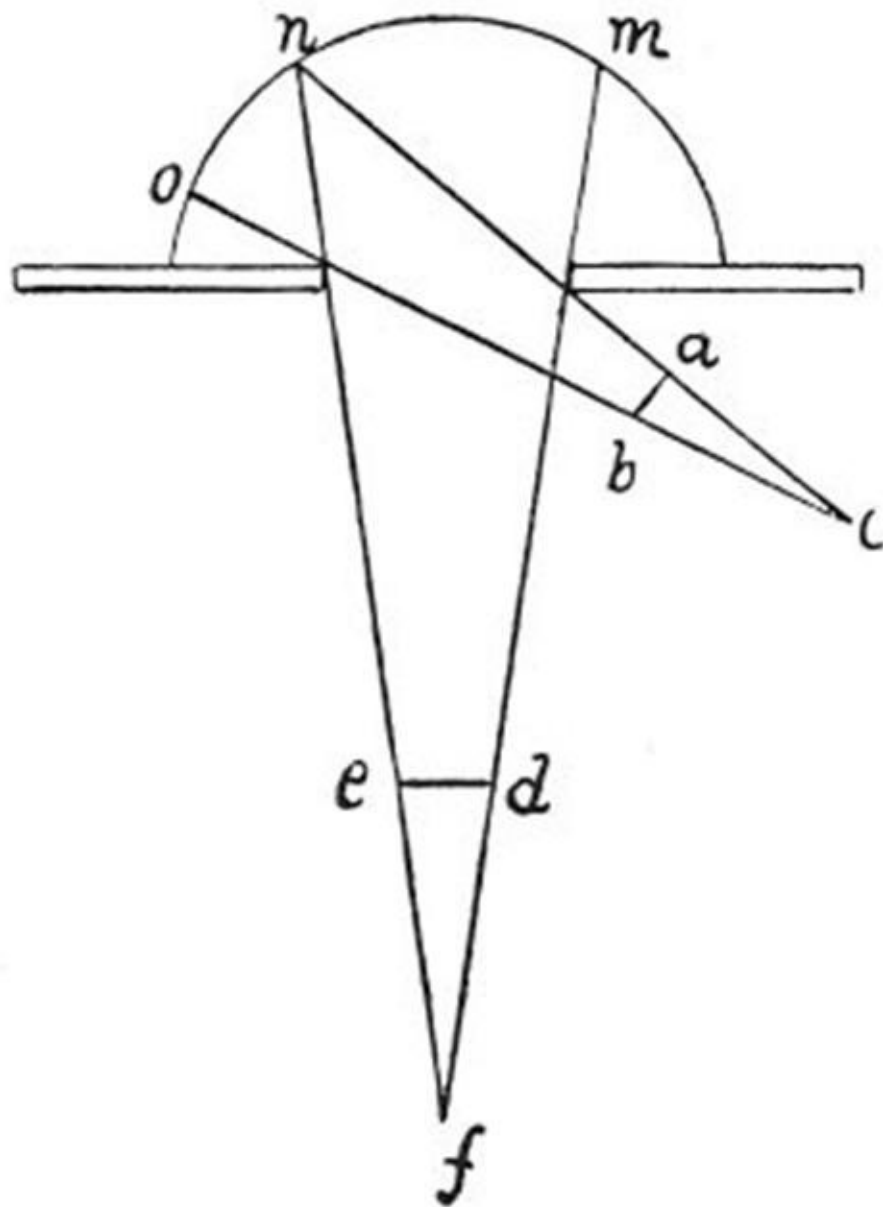




There they intersect and form 2 pyramids with their point meeting [a common apex] and their bases opposite. Let *a b* be the point of origin of the lines, *d e* the first plane, and *c* the aperture with the intersection of the lines; *f g* is the inner plane. You will find that *a* falls upon the inner plane below at *g*, and *b* which is below will go up to the spot *f*; it will be quite evident to experimenters that every luminous body has in itself a core or centre, from which and to which all the lines radiate which are sent forth by the surface of the luminous body and reflected back to it; or which, having been thrown out and not intercepted, are dispersed in the air.

131.

**THE RAYS WHETHER SHADED OR LUMINOUS
HAVE GREATER STRENGTH AND EFFECT AT
THEIR POINTS THAN AT THEIR SIDES.**



Although the points of luminous pyramids may extend into shaded places and those of pyramids of shadow into illuminated places, and though among the luminous pyramids one may start from a broader base than another; nevertheless, if by reason of their various length these luminous pyramids acquire angles of equal size their light will be equal; and the case will be the same with the pyramids of shadow; as may be seen in the intersected pyramids *a b c* and *d e f*, which though their bases differ in size are equal as to breadth and light.

[Footnote: 51 — 55: This supplementary paragraph is indicated as being a continuation of line 45, by two small crosses.]

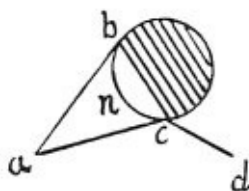
The difference between light and lustre (132 — 135).

132.

Of the difference between light and lustre; and that lustre is not included among colours, but is saturation of whiteness, and derived from the surface of wet bodies; light partakes of the colour of the object which reflects it (to the eye) as gold or silver or the like.

133.

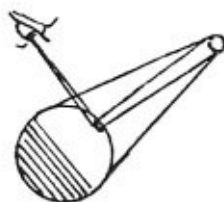
OF THE HIGHEST LIGHTS WHICH TURN AND MOVE AS THE EYE MOVES WHICH SEES THE OBJECT.



Suppose the body to be the round object figured here and let the light be at the point *a*, and let the illuminated side of the object be *b c* and the eye at the point *d*: I say that, as lustre is every where and complete in each part, if you stand at the point *d* the lustre will appear at *c*, and in proportion as the eye moves from *d* to *a*, the lustre will move from *c* to *n*.

134.

OF PAINTING.



Height of light or lustre on any object is not situated [necessarily] in the middle of an illuminated object, but moves as and where the eye moves in looking at it.

135.

OF LIGHT AND LUSTRE.

What is the difference between light and the lustre which is seen on the polished surface of opaque bodies?

The lights which are produced from the polished surface of opaque bodies will be stationary on stationary objects even if the eye on which they strike moves. But reflected lights will, on those same objects, appear in as many different places on the surface as different positions are taken by the eye.

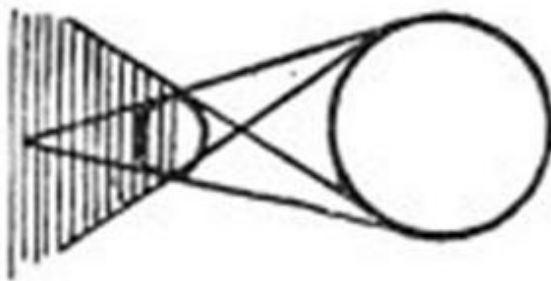
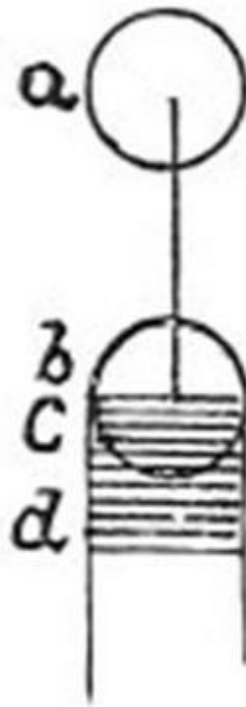
WHAT BODIES HAVE LIGHT UPON THEM WITHOUT LUSTRE?

Opaque bodies which have a hard and rough surface never display any lustre in any portion of the side on which the light falls.

WHAT BODIES WILL DISPLAY LUSTRE BUT NOT LOOK ILLUMINATED?

Those bodies which are opaque and hard with a hard surface reflect light [lustre] from every spot on the illuminated side which is in a position to receive light at the same angle of incidence as they occupy with regard to the eye; but, as the surface mirrors all the surrounding objects, the illuminated [body] is not recognisable in these portions of the illuminated body.

136.



The relations of luminous to illuminated bodies.

The middle of the light and shade on an object in light and shade is opposite to the middle of the primary light. All light and shadow expresses itself in pyramidal lines. The middle of the shadow on any object must necessarily be opposite the middle of its light, with a direct line passing through the centre of the body. The middle of the light will be at *a*, that of the shadow at *b*. [Again, in bodies shown in light and shade the middle of each must coincide with the centre of the body, and a straight line will pass through both and through that centre.]

[Footnote: In the original MS., at the spot marked *a* of the first diagram Leonardo wrote *primitiuo*, and at the spot marked *c* — *primitiva* (primary); at

the spot marked *b* he wrote *dirivatiuo* and at *d* *deriuatiua* (derived).]

Experiments on the relation of light and shadow within a room (137 — 140).

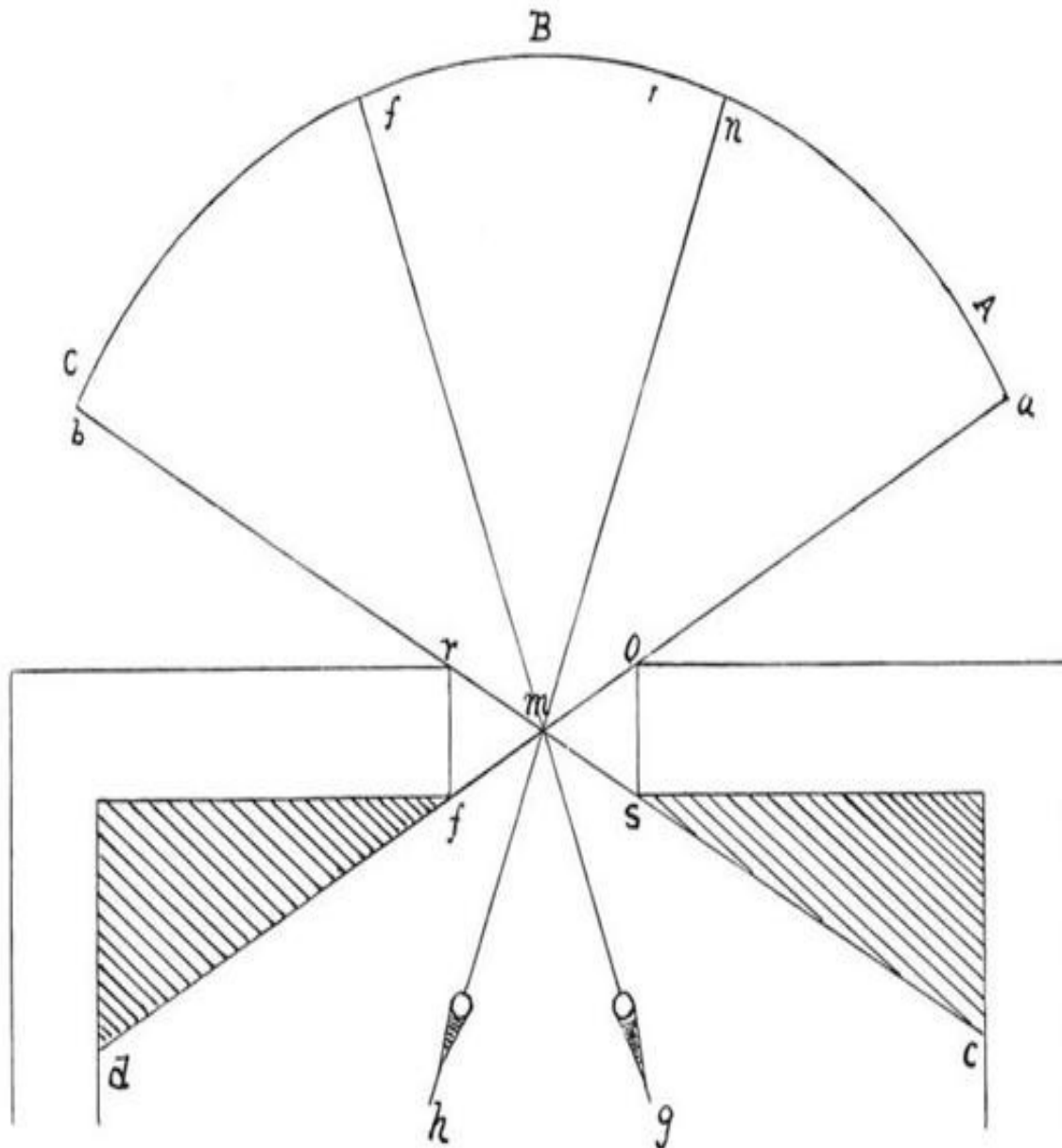
137.

SHOWS HOW LIGHT FROM ANY SIDE CONVERGES TO ONE POINT.

Although the balls *a b c* are lighted from one window, nevertheless, if you follow the lines of their shadows you will see they intersect at a point forming the angle *n*.

[Footnote: The diagram belonging to this passage is slightly sketched on Pl. XXXII; a square with three balls below it. The first three lines of the text belonging to it are written above the sketch and the six others below it.]

138.

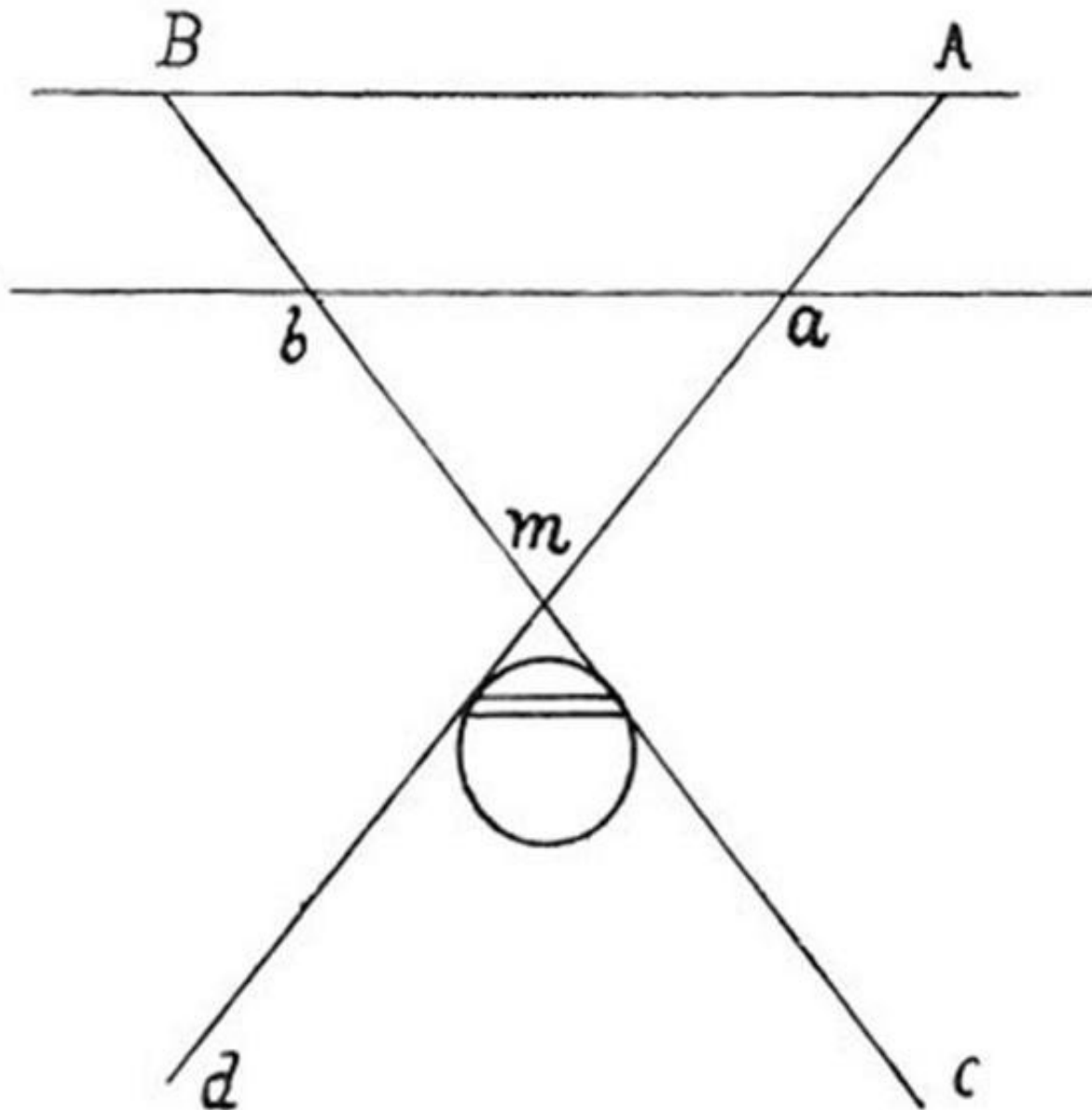


Every shadow cast by a body has a central line directed to a single point produced by the intersection of luminous lines in the middle of the opening and thickness of the window. The proposition stated above, is plainly seen by experiment. Thus if you draw a place with a window looking northwards, and let this be $s f$, you will see a line starting from the horizon to the east, which, touching the 2 angles of the window $o f$, reaches d ; and from the horizon on the west another line, touching the other 2 angles $r s$, and ending at c ; and their intersection falls exactly in the middle of the opening and thickness of the window. Again, you can still better confirm this proof by placing two sticks, as shown at $g h$; and you will see the line drawn from the centre of the shadow

directed to the centre *m* and prolonged to the horizon *n f*.

[Footnote: *B* here stands for *cerchio del' orizonte tramontano* on the original diagram (the circle of the horizon towards the North); *A* for *levante* (East) and *C* for *ponete* (West).]

139.

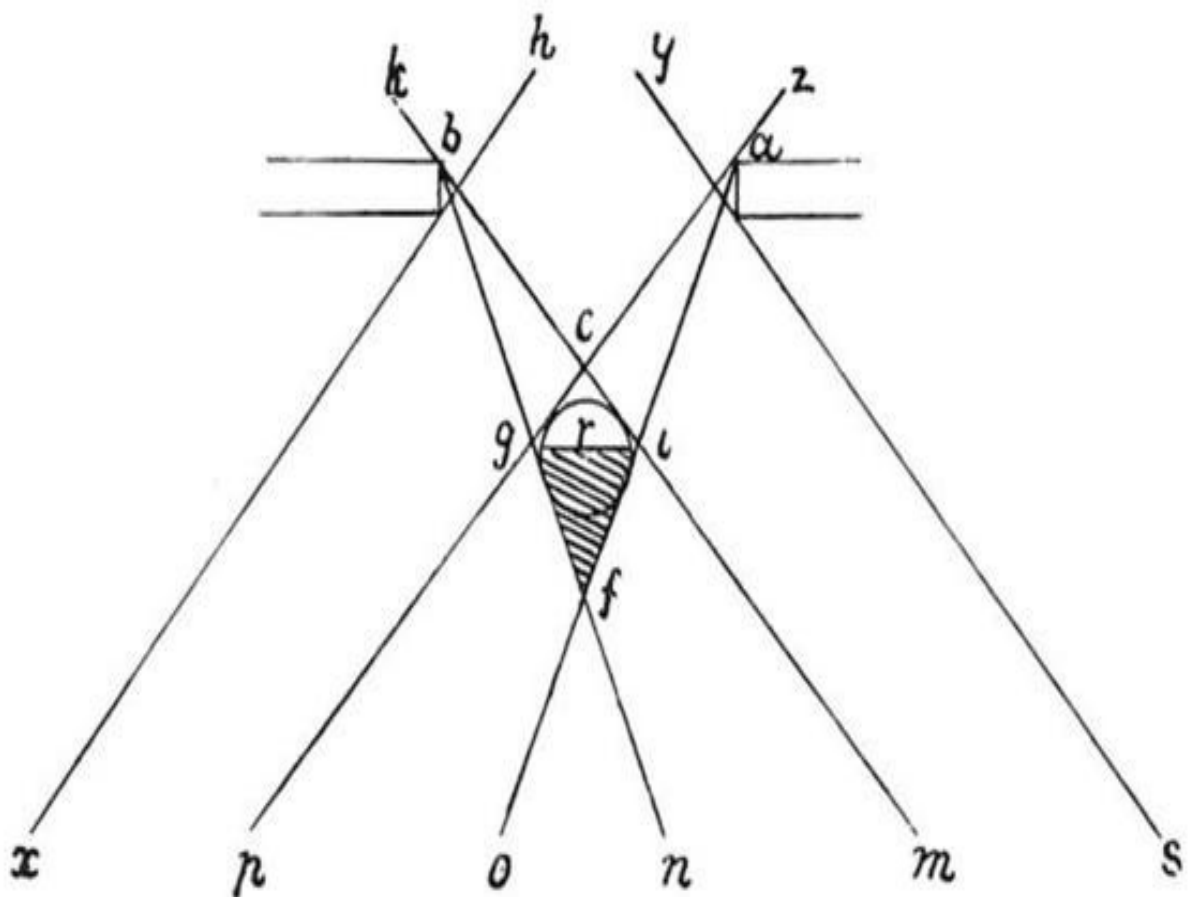


Every shadow with all its variations, which becomes larger as its distance from the object is greater, has its external lines intersecting in the middle,

between the light and the object. This proposition is very evident and is confirmed by experience. For, if $a b$ is a window without any object interposed, the luminous atmosphere to the right hand at a is seen to the left at d . And the atmosphere at the left illuminates on the right at c , and the lines intersect at the point m .

[Footnote: A here stands for *levante* (East), B for *ponente* (West).]

140.



Every body in light and shade is situated between 2 pyramids one dark and the other luminous, one is visible the other is not. But this only happens when the light enters by a window. Supposing $a b$ to be the window and r the body in light and shade, the light to the right hand z will pass the object to the left and go on to p ; the light to the left at k will pass to the right of the object at i and go on to m and the two lines will intersect at c and form a pyramid. Then again $a b$ falls on the shaded body at $i g$ and forms a pyramid $f i g$. f will be dark because the light

a b can never fall there; *i g c* will be illuminated because the light falls upon it.
Light and shadow with regard to the position of the eye (141 — 145).

141.

Every shaded body that is larger than the pupil and that interposes between the luminous body and the eye will be seen dark.

When the eye is placed between the luminous body and the objects illuminated by it, these objects will be seen without any shadow.

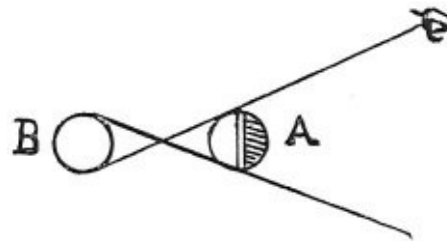
[Footnote: The diagram which in the original stands above line 1 is given on Plate II, No 2. Then, after a blank space of about eight lines, the diagram Plate II No 3 is placed in the original. There is no explanation of it beyond the one line written under it.]

142.

Why the 2 lights one on each side of a body having two pyramidal sides of an obtuse apex leave it devoid of shadow.

[Footnote: The sketch illustrating this is on Plate XLI No 1.]

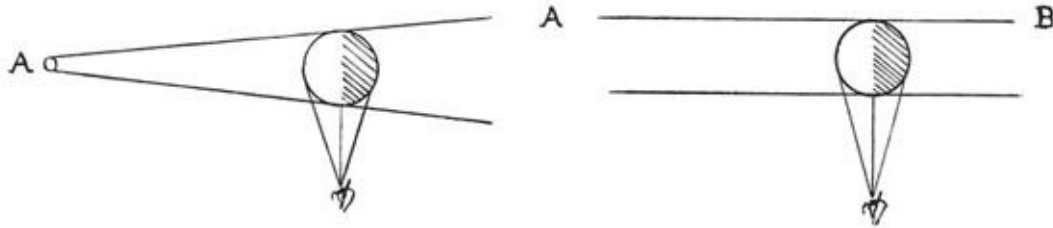
143.



A body in shadow situated between the light and the eye can never display its illuminated portion unless the eye can see the whole of the primary light.

[Footnote: *A* stands for *corpo* (body), *B* for *lume* (light).]

144.



The eye which looks (at a spot) half way between the shadow and the light which surrounds the body in shadow will see that the deepest shadows on that body will meet the eye at equal angles, that is at the same angle as that of sight.

[Footnote: In both these diagrams *A* stands for *lume* (light) *B* for *ombra* (shadow).]

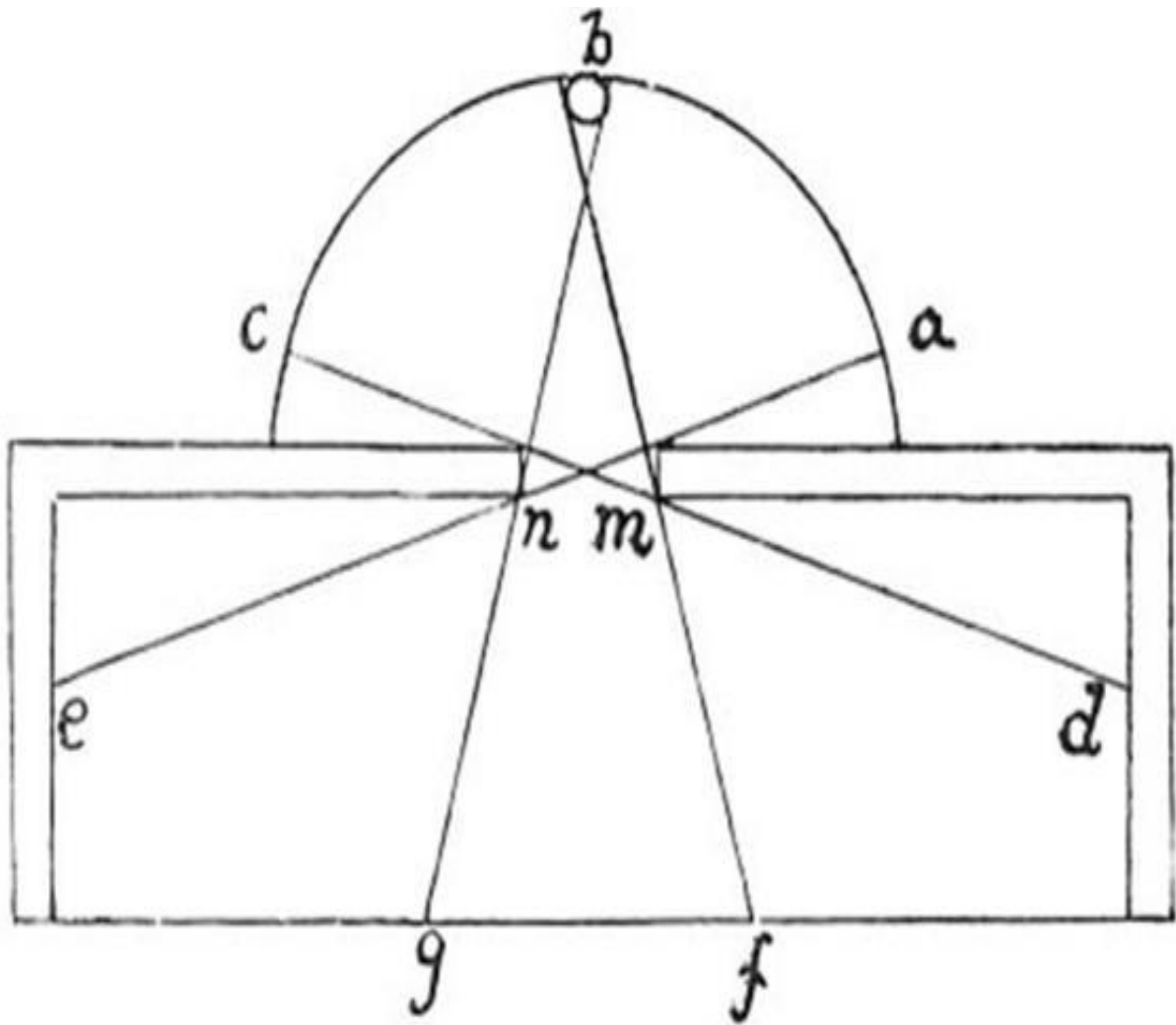
145.

OF THE DIFFERENT LIGHT AND SHADE IN VARIOUS ASPECTS AND OF OBJECTS PLACED IN THEM.

If the sun is in the East and you look towards the West you will see every thing in full light and totally without shadow because you see them from the same side as the sun: and if you look towards the South or North you will see all objects in light and shade, because you see both the side towards the sun and the side away from it; and if you look towards the coming of the sun all objects will show you their shaded side, because on that side the sun cannot fall upon them.

The law of the incidence of light.

146.



The edges of a window which are illuminated by 2 lights of equal degrees of brightness will not reflect light of equal brightness into the chamber within.

If *b* is a candle and *a c* our hemisphere both will illuminate the edges of the window *m n*, but light *b* will only illuminate *f g* and the hemisphere *a* will light all of *d e*.

147.

OF PAINTING.

That part of a body which receives the luminous rays at equal angles will be in a higher light than any other part of it.

And the part which the luminous rays strike between less equal angles will be less strongly illuminated.

SECOND BOOK ON LIGHT AND SHADE.

Gradations of strength in the shadows (148. 149).

148.

THAT PORTION OF A BODY IN LIGHT AND SHADE WILL BE LEAST LUMINOUS WHICH IS SEEN UNDER THE LEAST AMOUNT OF LIGHT.

That part of the object which is marked *m* is in the highest light because it faces the window *a d* by the line *a f*; *n* is in the second grade because the light *b d* strikes it by the line *b e*; *o* is in the third grade, as the light falls on it from *c d* by the line *c h*; *p* is the lowest light but one as *c d* falls on it by the line *d v*; *q* is the deepest shadow for no light falls on it from any part of the window.

In proportion as *c d* goes into *a d* so will *n r s* be darker than *m*, and all the rest is space without shadow.

[Footnote: The diagram belonging to this chapter is No. 1 on Plate III. The letters *a b e d* and *r* are not reproduced in facsimile of the original, but have been replaced by ordinary type in the margin. 5-12. The original text of these lines is reproduced within the diagram. — Compare No 275.]

149.

The light which falls on a shaded body at the acutest angle receives the highest light, and the darkest portion is that which receives it at an obtuse angle and both the light and the shadow form pyramids. The angle *c* receives the highest grade of light because it is directly in front of the window *a b* and the whole horizon of the sky *m x*. The angle *a* differs but little from *c* because the angles which divide it are not so unequal as those below, and only that portion of the horizon is

intercepted which lies between y and x . Although it gains as much on the other side its line is nevertheless not very strong because one angle is smaller than its fellow. The angles $e i$ will have less light because they do not see much of the light $m s$ and the light $v x$ and their angles are very unequal. The angle k and the angle f are each placed between very unequal angles and therefore have but little light, because at k it has only the light $p t$, and at f only $t q$; $o g$ is the lowest grade of light because this part has no light at all from the sky; and thence come the lines which will reconstruct a pyramid that is the counterpart of the pyramid c ; and this pyramid l is in the first grade of shadow; for this too is placed between equal angles directly opposite to each other on either side of a straight line which passes through the centre of the body and goes to the centre of the light. The several luminous images cast within the frame of the window at the points a and b make a light which surrounds the derived shadow cast by the solid body at the points 4 and 6. The shaded images increase from $o g$ and end at 7 and 8.

[Footnote: The diagram belonging to this chapter is No. 2 on Plate III. In the original it is placed between lines 3 and 4, and in the reproduction these are shown in part. The semi circle above is marked *orizonte* (horizon). The number 6 at the left hand side, outside the facsimile, is in the place of a figure which has become indistinct in the original.]

On the intensity of shadows as dependent on the distance from the light (150-152).

150.

The smaller the light that falls upon an object the more shadow it will display. And the light will illuminate a smaller portion of the object in proportion as it is nearer to it; and conversely, a larger extent of it in proportion as it is farther off.

A light which is smaller than the object on which it falls will light up a smaller extent of it in proportion as it is nearer to it, and the converse, as it is farther from it. But when the light is larger than the object illuminated it will light a larger extent of the object in proportion as it is nearer and the converse when they are farther apart.

151.

That portion of an illuminated object which is nearest to the source of light

will be the most strongly illuminated.

152.

That portion of the primary shadow will be least dark which is farthest from the edges.

The derived shadow will be darker than the primary shadow where it is contiguous with it.

On the proportion of light and shade (153-157).

153.

That portion of an opaque body will be more in shade or more in light, which is nearer to the dark body, by which it is shaded, or to the light that illuminates it.

Objects seen in light and shade show in greater relief than those which are wholly in light or in shadow.

154.

OF PERSPECTIVE.

The shaded and illuminated sides of opaque objects will display the same proportion of light and darkness as their objects [Footnote 6: The meaning of *obbietti* (objects) is explained in no 153, lines 1-4. — Between the title-line and the next there is, in the original, a small diagram representing a circle described round a square.].

155.

OF PAINTING.

The outlines and form of any part of a body in light and shade are indistinct in the shadows and in the high lights; but in the portions between the light and the shadows they are highly conspicuous.

156.

OF PAINTING.

Among objects in various degrees of shade, when the light proceeds from a single source, there will be the same proportion in their shadows as in the natural diminution of the light and the same must be understood of the degrees of light.

157.

A single and distinct luminous body causes stronger relief in the object than a diffused light; as may be seen by comparing one side of a landscape illuminated by the sun, and one overshadowed by clouds, and so illuminated only by the diffused light of the atmosphere.

THIRD BOOK ON LIGHT AND SHADE.

Definition of derived shadow (158. 159).

158.

Derived shadow cannot exist without primary shadow. This is proved by the first of this which says: Darkness is the total absence of light, and shadow is an alleviation of darkness and of light, and it is more or less dark or light in proportion as the darkness is modified by the light.

159.

Shadow is diminution of light.

Darkness is absence of light.

Shadow is divided into two kinds, of which the first is called primary shadow, the second is derived shadow. The primary shadow is always the basis of the derived shadow.

The edges of the derived shadow are straight lines.

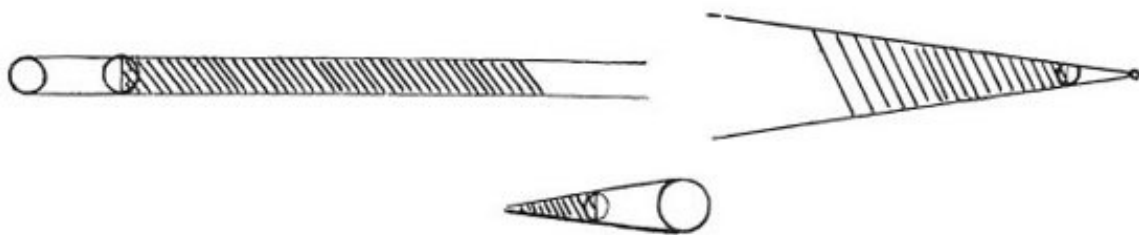
[Footnote: The theory of the *ombra dirivativa* — a technical expression for which there is no precise English equivalent is elaborately treated by Leonardo. But both text and diagrams (as Pl. IV, 1-3 and Pl. V) must at once convince the student that the distinction he makes between *ombra primitiva* and *ombra dirivativa* is not merely justifiable but scientific. *Ombra dirivativa* is by no means a mere abstract idea. This is easily proved by repeating the experiment made by Leonardo, and by filling with smoke the room in which the existence of the *ombra dirivativa* is investigated, when the shadow becomes visible. Nor is it difficult to perceive how much of Leonardo's teaching depended on this theory. The recognised, but extremely complicated science of cast shadows — *percussione dell' ombre dirivative* as Leonardo calls them — is thus rendered more intelligible if not actually simpler, and we must assume this theory as our chief guide through the investigations which follow.]

The darkness of the derived shadow diminishes in proportion as it is remote from the primary shadow.

Different sorts of derived shadows (160-162).

160.

SHADOW AND LIGHT.

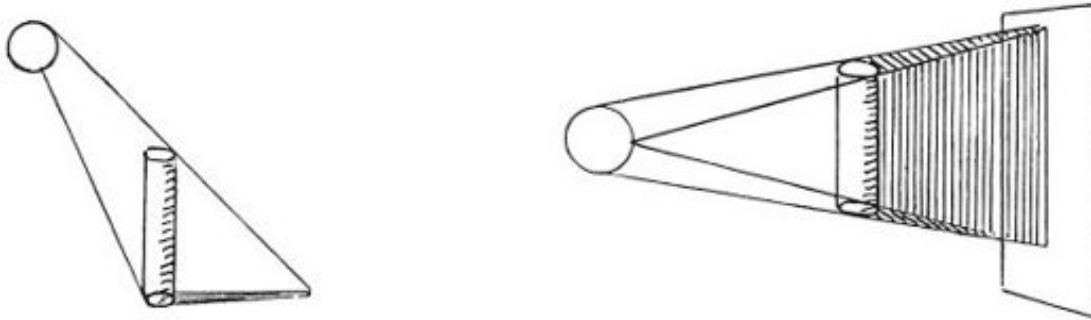


The forms of shadows are three: inasmuch as if the solid body which casts the shadow is equal (in size) to the light, the shadow resembles a column without any termination (in length). If the body is larger than the light the shadow resembles a truncated and inverted pyramid, and its length has also no defined

termination. But if the body is smaller than the light, the shadow will resemble a pyramid and come to an end, as is seen in eclipses of the moon.

161.

OF SIMPLE DERIVED SHADOWS.



The simple derived shadow is of two kinds: one kind which has its length defined, and two kinds which are undefined; and the defined shadow is pyramidal. Of the two undefined, one is a column and the other spreads out; and all three have rectilinear outlines. But the converging, that is the pyramidal, shadow proceeds from a body that is smaller than the light, and the columnar from a body equal in size to the light, and the spreading shadow from a body larger than the light; &c.

OF COMPOUND DERIVED SHADOWS.

Compound derived shadows are of two kinds; that is columnar and spreading.

162.

OF SHADOW.

Derived shadows are of three kinds of which one is spreading, the second columnar, the third converging to the point where the two sides meet and

intersect, and beyond this intersection the sides are infinitely prolonged or straight lines. And if you say, this shadow must terminate at the angle where the sides meet and extend no farther, I deny this, because above in the first on shadow I have proved: that a thing is completely terminated when no portion of it goes beyond its terminating lines. Now here, in this shadow, we see the converse of this, in as much as where this derived shadow originates we obviously have the figures of two pyramids of shadow which meet at their angles. Hence, if, as [my] opponent says, the first pyramid of shadow terminates the derivative shadow at the angle whence it starts, then the second pyramid of shadow — so says the adversary — must be caused by the angle and not from the body in shadow; and this is disproved with the help of the 2nd of this which says: Shadow is a condition produced by a body casting a shadow, and interposed between this shadow and the luminous body. By this it is made clear that the shadow is not produced by the angle of the derived shadow but only by the body casting the shadow; &c. If a spherical solid body is illuminated by a light of elongated form the shadow produced by the longest portion of this light will have less defined outlines than that which is produced by the breadth of the same light. And this is proved by what was said before, which is: That a shadow will have less defined outlines in proportion as the light which causes it is larger, and conversely, the outlines are clearer in proportion as it is smaller.

[Footnote: The two diagrams to this chapter are on Plate IV, No. 1.]

On the relation of derived and primary shadow (163-165).

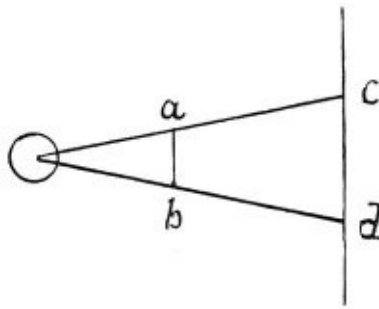
163.

The derived shadow can never resemble the body from which it proceeds unless the light is of the same form and size as the body causing the shadow.

The derived shadow cannot be of the same form as the primary shadow unless it is intercepted by a plane parallel to it.

164.

HOW A CAST SHADOW CAN NEVER BE OF THE SAME SIZE AS THE BODY THAT CASTS IT.



If the rays of light proceed, as experience shows, from a single point and are diffused in a sphere round this point, radiating and dispersed through the air, the farther they spread the wider they must spread; and an object placed between the light and a wall is always imaged larger in its shadow, because the rays that strike it [Footnote: 7. The following lines are wanting to complete the logical connection.] would, by the time they have reached the wall, have become larger.

165.



Any shadow cast by a body in light and shade is of the same nature and character as that which is inseparable from the body. The centre of the length of a shadow always corresponds to that of the luminous body [Footnote 6: This second statement of the same idea as in the former sentence, but in different words, does not, in the original, come next to the foregoing; sections 172 and 127 are placed between them.]. It is inevitable that every shadow must have its centre in a line with the centre of the light.

On the shape of derived shadows (166-174).

166.

OF THE PYRAMIDAL SHADOW.

The pyramidal shadow produced by a columnar body will be narrower than the body itself in proportion as the simple derived shadow is intersected farther from the body which casts it.

[Footnote 166: Compare the first diagram to No. 161. If we here conceive of the outlines of the pyramid of shadow on the ground as prolonged beyond its apex this gives rise to a second pyramid; this is what is spoken of at the beginning of No. 166.]

167.

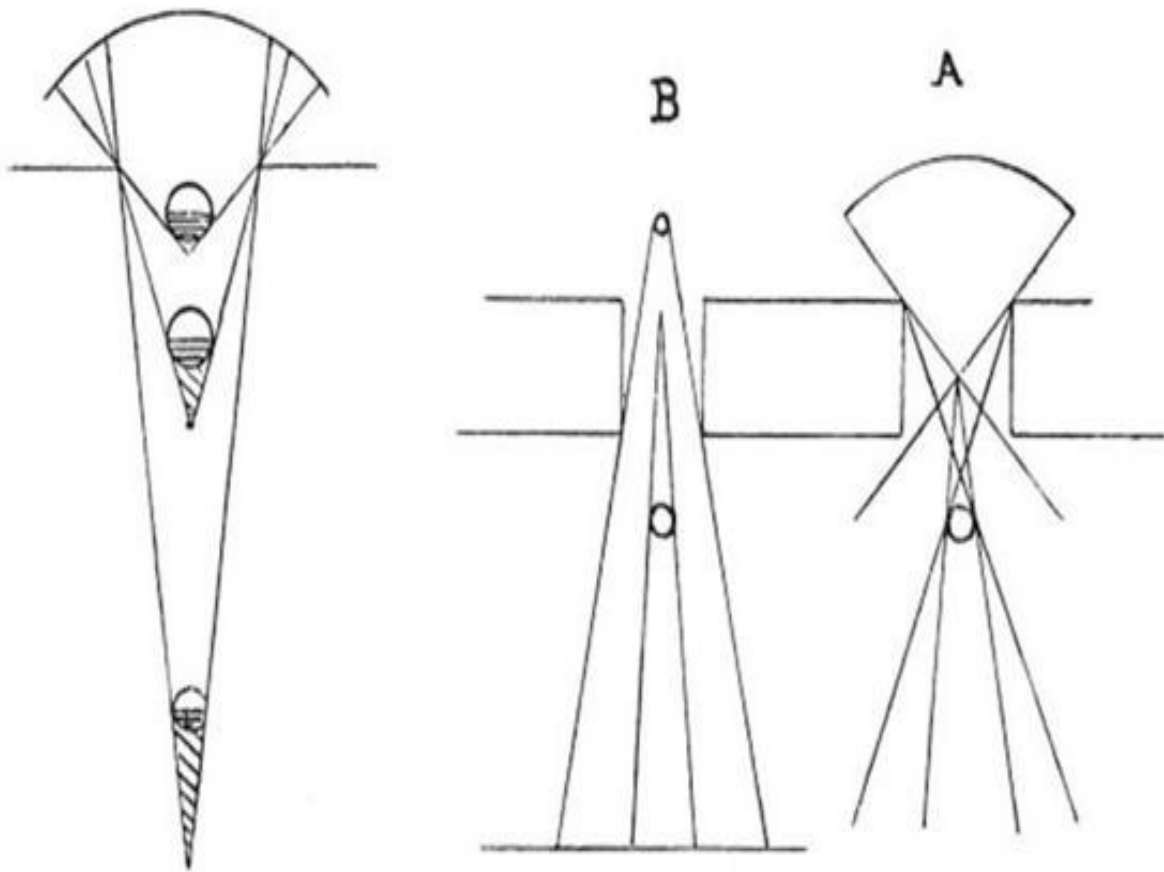


The

cast shadow will be longest when the light is lowest.

The cast shadow will be shortest when the light is highest.

168.



Both the primary and derived shadow will be larger when caused by the light of a candle than by diffused light. The difference between the larger and smaller shadows will be in inverse proportion to the larger and smaller lights causing them.

[Footnote: In the diagrams *A* stands for *celo* (sky), *B* for *cadela* (candle).]

169.

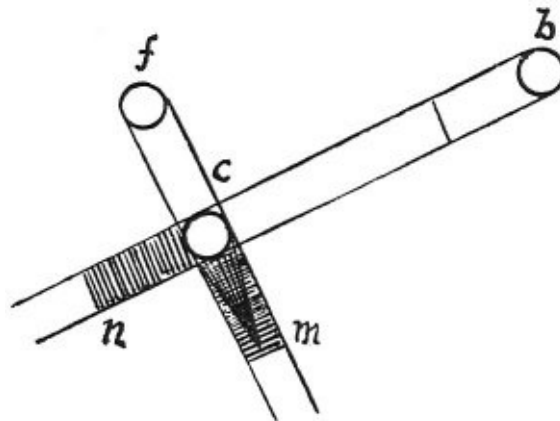
ALL BODIES, IN PROPORTION AS THEY ARE NEARER TO, OR FARTHER FROM THE SOURCE OF LIGHT, WILL PRODUCE LONGER OR SHORTER DERIVED SHADOWS.

Among bodies of equal size, that one which is illuminated by the largest light will have the shortest shadow. Experiment confirms this proposition. Thus the

body $m n$ is surrounded by a larger amount of light than the body $p q$, as is shown above. Let us say that $v c a b d x$ is the sky, the source of light, and that $s t$ is a window by which the luminous rays enter, and so $m n$ and $p q$ are bodies in light and shade as exposed to this light; $m n$ will have a small derived shadow, because its original shadow will be small; and the derivative light will be large, again, because the original light $c d$ will be large and $p q$ will have more derived shadow because its original shadow will be larger, and its derived light will be smaller than that of the body $m n$ because that portion of the hemisphere $a b$ which illuminates it is smaller than the hemisphere $c d$ which illuminates the body $m n$.

[Footnote: The diagram, given on Pl. IV, No. 2, stands in the original between lines 2 and 7, while the text of lines 3 to 6 is written on its left side. In the reproduction of this diagram the letter v at the outer right-hand end has been omitted.]

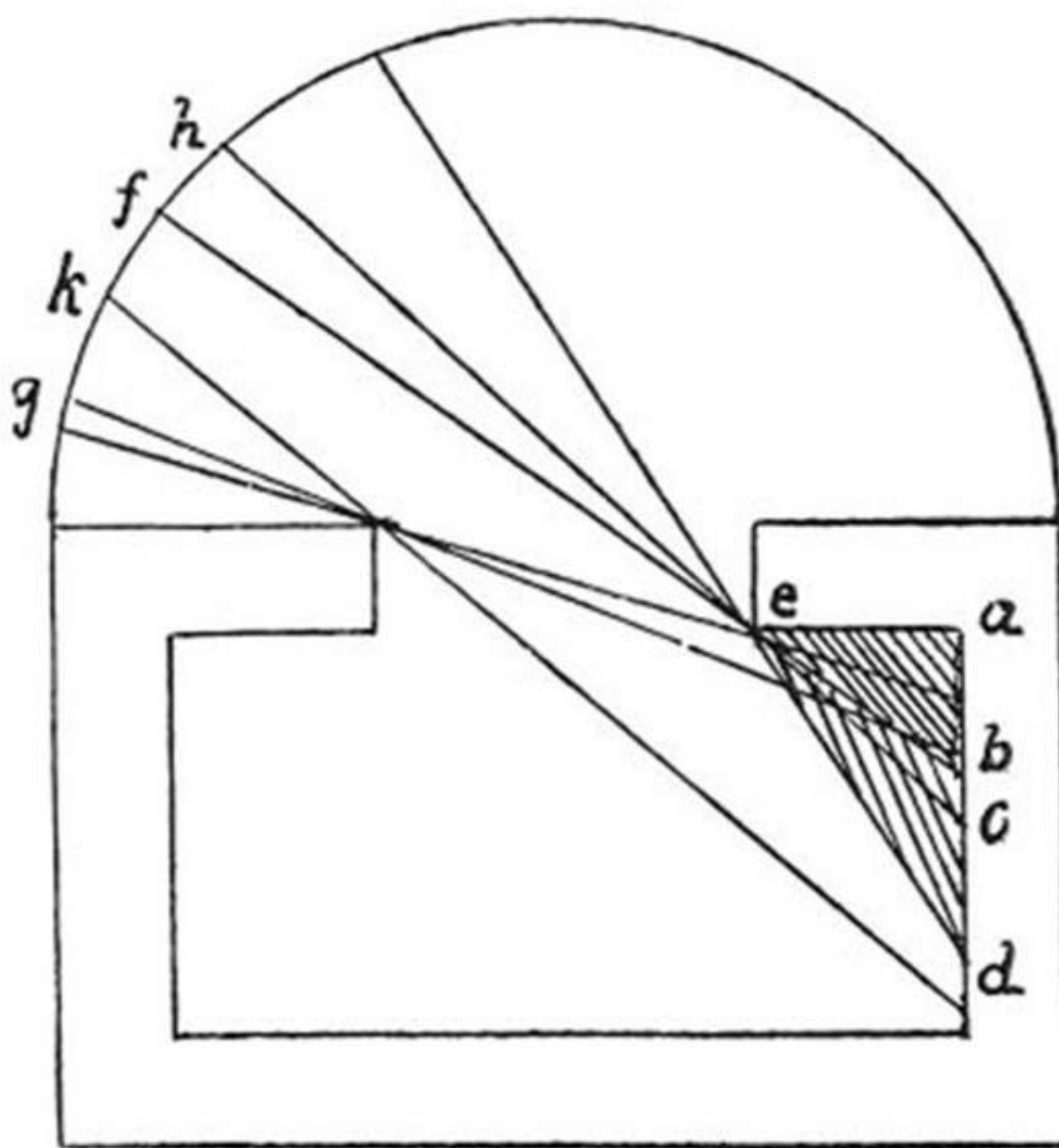
170.



The shadow m bears the same proportion to the shadow n as the line $b c$ to the line $f c$.

171.

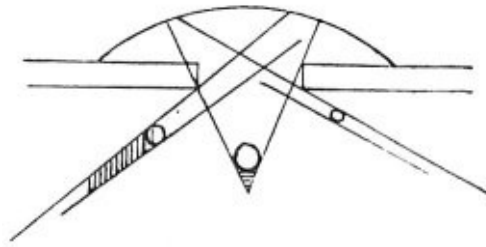
OF PAINTING.



Of different shadows of equal strength that which is nearest the eye will seem the least strong.

Why is the shadow *e a b* in the first grade of strength, *b c* in the second; *c d* in the third? The reason is that as from *e a b* the sky is nowhere visible, it gets no light whatever from the sky, and so has no direct [primary] light. *b c* faces the portion of the sky *f g* and is illuminated by it. *c d* faces the sky at *h k*. *c d*, being exposed to a larger extent of sky than *b c*, it is reasonable that it should be more lighted. And thus, up to a certain distance, the wall *a d* will grow lighter for the reasons here given, until the darkness of the room overpowers the light from the window.

172.



When the light of the atmosphere is restricted [by an opening] and illuminates bodies which cast shadows, these bodies being equally distant from the centre of the window, that which is most obliquely placed will cast the largest shadow beyond it.

173.

These bodies standing apart in a room lighted by a single window will have derivative shadows more or less short according as they are more or less opposite to the window. Among the shadows cast by bodies of equal mass but at unequal distances from the opening by which they are illuminated, that shadow will be the longest of the body which is least in the light. And in proportion as one body is better illuminated than another its shadow will be shorter than another. The proportion $n m$ and $e v k$ bear to $r t$ and $v x$ corresponds with that of the shadow x to 4 and y .

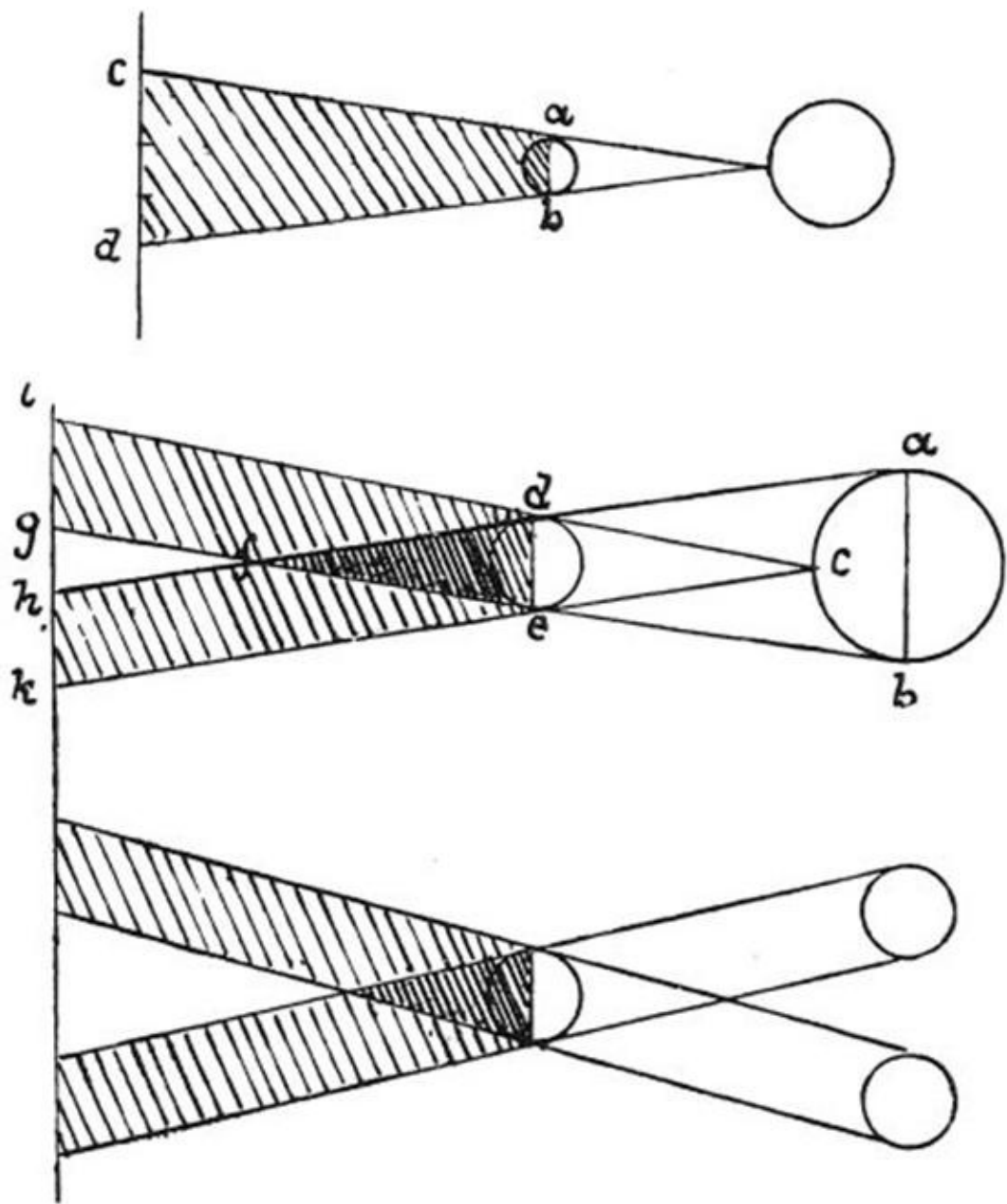
The reason why those bodies which are placed most in front of the middle of the window throw shorter shadows than those obliquely situated is: — That the window appears in its proper form and to the obliquely placed ones it appears foreshortened; to those in the middle, the window shows its full size, to the oblique ones it appears smaller; the one in the middle faces the whole hemisphere that is $e f$ and those on the side have only a strip; that is $q r$ faces $a b$; and $m n$ faces $c d$; the body in the middle having a larger quantity of light than those at the sides is lighted from a point much below its centre, and thus the shadow is shorter. And the pyramid $g 4$ goes into $l y$ exactly as often as $a b$ goes into $e f$. The axis of every derivative shadow passes through $6 \frac{1}{2}$ [Footnote 31: *passa per* $6 \frac{1}{2}$ (passes through $6 \frac{1}{2}$). The meaning of these words is probably this: Each of the three axes of the derived shadow intersects the centre (*mezzo*) of the primary shadow (*ombra originale*) and, by prolongation upwards crosses six lines.

This is self evident only in the middle diagram; but it is equally true of the side figures if we conceive of the lines $4 f$, $x n v m$, $y l k v$, and $4 e$, as prolonged beyond the semicircle of the horizon.] and is in a straight line with the centre of the primary shadow, with the centre of the body casting it and of the derivative light and with the centre of the window and, finally, with the centre of that portion of the source of light which is the celestial hemisphere, $y h$ is the centre of the derived shade, $l h$ of the primary shadow, l of the body throwing it, $l k$ of the derived light, v is the centre of the window, e is the final centre of the original light afforded by that portion of the hemisphere of the sky which illuminates the solid body.

[Footnote: Compare the diagram on Pl. IV, No. 3. In the original this drawing is placed between lines 3 and 22; the rest, from line 4 to line 21, is written on the left hand margin.]

174.

**THE FARTHER THE DERIVED SHADOW IS PROLONGED THE
LIGHTER IT BECOMES.**



You will find that the proportion of the diameter of the derived shadow to that of the primary shadow will be the same as that between the darkness of the primary shadow and that of the derived shadow.

[Footnote 6: Compare No. 177.] Let $a b$ be the diameter of the primary shadow and $c d$ that of the derived shadow, I say that $a b$ going, as you see, three times into $d c$, the shadow $d c$ will be three times as light as the shadow $a b$. [Footnote 8: Compare No. 177.]

If the size of the illuminating body is larger than that of the illuminated body an intersection of shadow will occur, beyond which the shadows will run off in two opposite directions as if they were caused by two separate lights.

On the relative intensity of derived shadows (175-179).

175.

ON PAINTING.

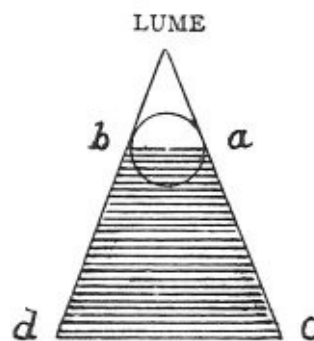
The derived shadow is stronger in proportion as it is nearer to its place of origin.

176.

HOW SHADOWS FADE AWAY AT LONG DISTANCES.

Shadows fade and are lost at long distances because the larger quantity of illuminated air which lies between the eye and the object seen tints the shadow with its own colour.

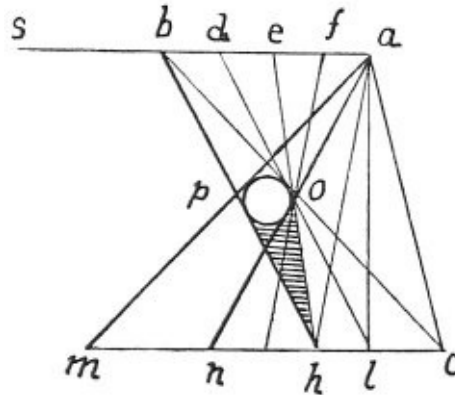
177.



a b will be darker than *c d* in proportion as *c d* is broader than *a b*.

[Footnote: In the original MS. the word *lume* (light) is written at the apex of the pyramid.]

178.



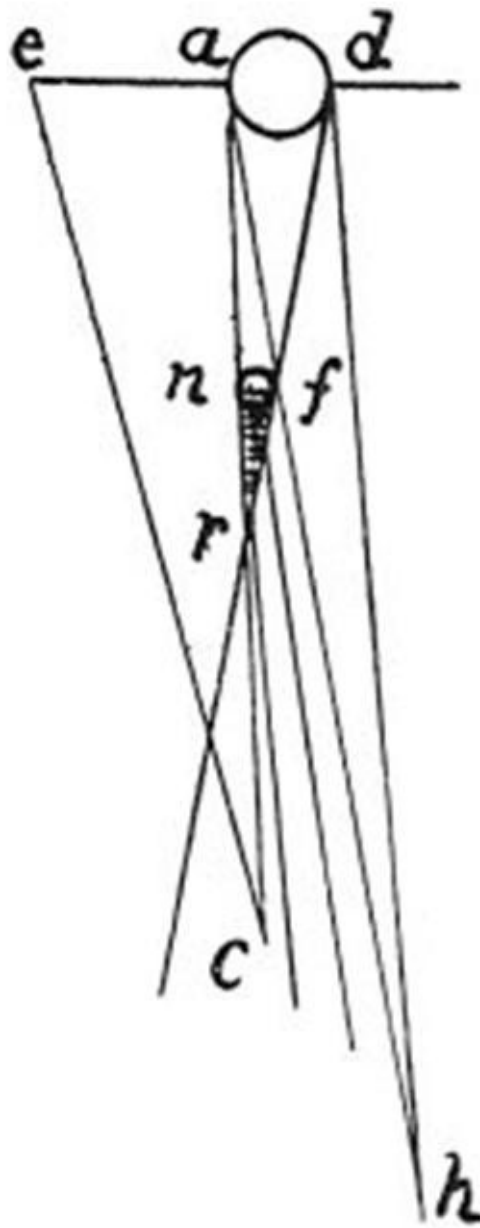
It can be proved why the shadow $o p c h$ is darker in proportion as it is nearer to the line $p h$ and is lighter in proportion as it is nearer to the line $o c$. Let the light $a b$, be a window, and let the dark wall in which this window is, be $b s$, that is, one of the sides of the wall.

Then we may say that the line $p h$ is darker than any other part of the space $o p c h$, because this line faces the whole surface in shadow of [Footnote: In the original the diagram is placed between lines 27 and 28.] the wall $b s$. The line $o c$ is lighter than the other part of this space $o p c h$, because this line faces the luminous space $a b$.

Where the shadow is larger, or smaller, or equal the body which casts it.

[First of the character of divided lights. [Footnote 14: *lumi divisi*. The text here breaks off abruptly.]

OF THE COMPOUND SHADOW F, R, C, H CAUSED BY A SINGLE LIGHT.



The shadow $f r c h$ is under such conditions as that where it is farthest from its inner side it loses depth in proportion. To prove this:

Let $d a$, be the light and $f n$ the solid body, and let $a e$ be one of the side walls of the window that is $d a$. Then I say — according to the 2nd [proposition]: that the surface of any body is affected by the tone of the objects surrounding it, — that the side $r c$, which faces the dark wall $a e$ must participate of its darkness and, in the same way that the outer surface which faces the light $d a$ participates of the light; thus we get the outlines of the extremes on each side of the centre included between them.]

This is divided into four parts. The first the extremes, which include the

compound shadow, secondly the compound shadow between these extremes.

179.

THE ACTION OF THE LIGHT AS FROM ITS CENTRE.

If it were the whole of the light that caused the shadows beyond the bodies placed in front of it, it would follow that any body much smaller than the light would cast a pyramidal shadow; but experience not showing this, it must be the centre of the light that produces this effect.

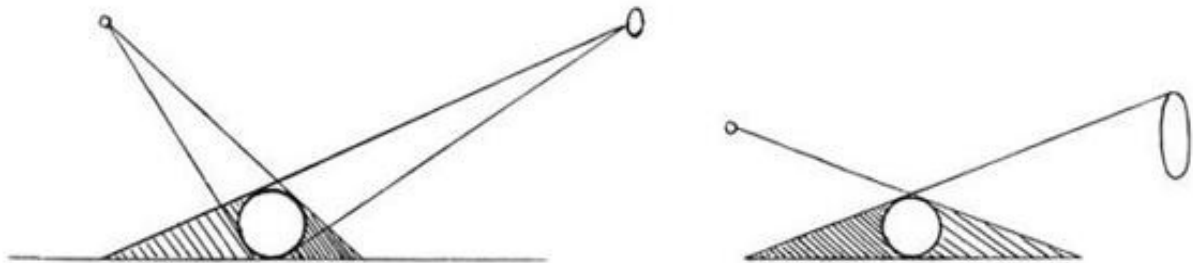
[Footnote: The diagram belonging to this passage is between lines 4 and 5 in the original. Comp. the reproduction Pl. IV, No. 4. The text and drawing of this chapter have already been published with tolerable accuracy. See M. JORDAN: "*Das Malerbuch des Leonardo da Vinci*". Leipzig 1873, P. 90.]

PROOF.

Let $a b$ be the width of the light from a window, which falls on a stick set up at one foot from $a c$ [Footnote 6: *bastone* (stick). The diagram has a sphere in place of a stick.]. And let $a d$ be the space where all the light from the window is visible. At $c e$ that part of the window which is between $l b$ cannot be seen. In the same way $a m$ cannot be seen from $d f$ and therefore in these two portions the light begins to fail.

Shadow as produced by two lights of different size (180. 181).

180.



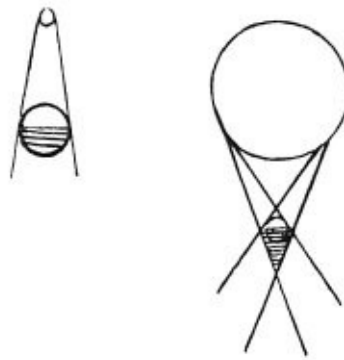
A body in light and shade placed between two equal lights side by side will

cast shadows in proportion to the [amount of] light. And the shadows will be one darker than the other in proportion as one light is nearer to the said body than the other on the opposite side.

A body placed at an equal distance between two lights will cast two shadows, one deeper than the other in proportion, as the light which causes it is brighter than the other.

[Footnote: In the MS. the larger diagram is placed above the first line; the smaller one between l. 4 & 5.]

181.



A light which is smaller than the body it illuminates produces shadows of which the outlines end within [the surface of] the body, and not much compound shadow; and falls on less than half of it. A light which is larger than the body it illuminates, falls on more than half of it, and produces much compound shadow.

The effect of light at different distances.

182.

OF THE SHADOW CAST BY A BODY PLACED BETWEEN 2 EQUAL LIGHTS.

A body placed between 2 equal lights will cast 2 shadows of itself in the direction of the lines of the 2 lights; and if you move this body placing it nearer to one of the lights the shadow cast towards the nearer light will be less deep than that which falls towards the more distant one.

Further complications in the derived shadows (183-187).

183.

The greatest depth of shadow is in the simple derived shadow because it is not lighted by either of the two lights *a b*, *c d*.

The next less deep shadow is the derived shadow *e f n*; and in this the shadow is less by half, because it is illuminated by a single light, that is *c d*.

This is uniform in natural tone because it is lighted throughout by one only of the two luminous bodies . But it varies with the conditions of shadow, inasmuch as the farther it is away from the light the less it is illuminated by it .

The third degree of depth is the middle shadow [Footnote 15: We gather from what follows that *q g r* here means *ombra media* (the middle shadow).]. But this is not uniform in natural tone; because the nearer it gets to the simple derived shadow the deeper it is [Footnote 18: Compare lines 10-13], and it is the uniformly gradual diminution by increase of distance which is what modifies it [Footnote 20: See Footnote 18]: that is to say the depth of a shadow increases in proportion to the distance from the two lights.

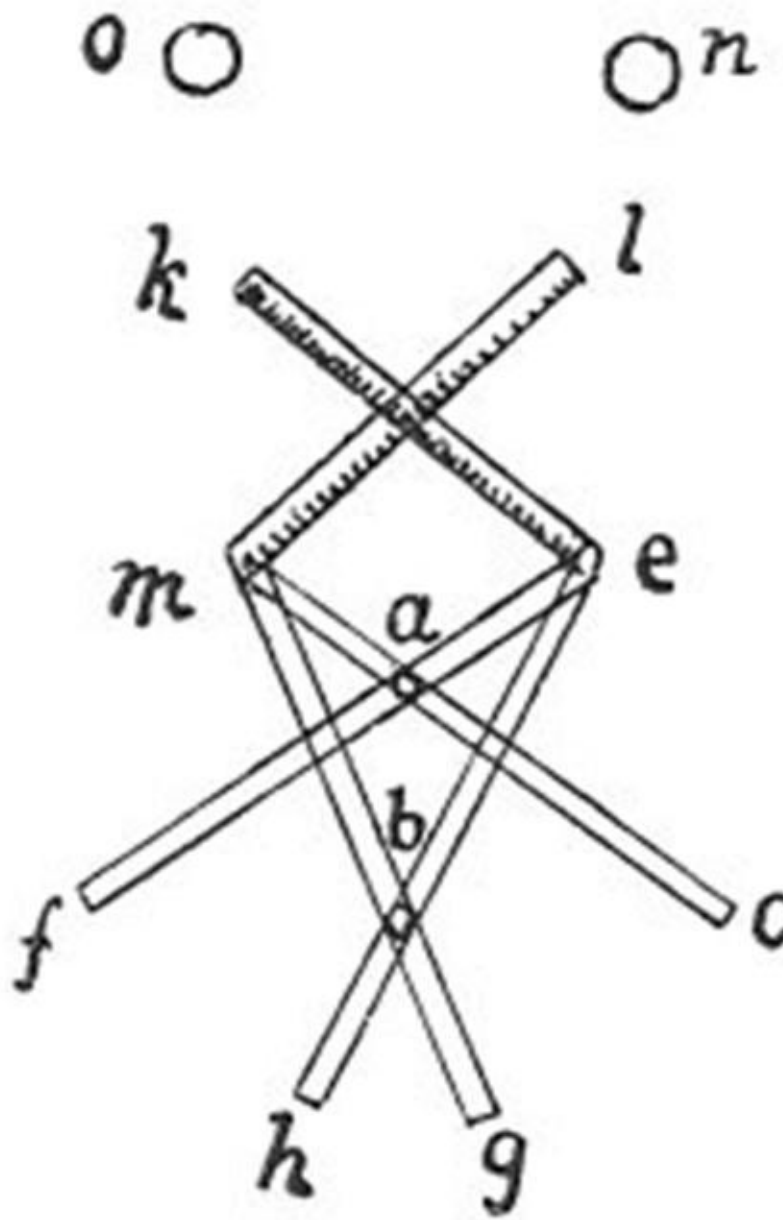
The fourth is the shadow *k r s* and this is all the darker in natural tone in proportion as it is nearer to *k s*, because it gets less of the light *a o*, but by the accident [of distance] it is rendered less deep, because it is nearer to the light *c d*, and thus is always exposed to both lights.

The fifth is less deep in shadow than either of the others because it is always entirely exposed to one of the lights and to the whole or part of the other; and it is less deep in proportion as it is nearer to the two lights, and in proportion as it is turned towards the outer side *x t*; because it is more exposed to the second light *a b*.

[Footnote: The diagram to this section is given on Pl. V. To the left is the facsimile of the beginning of the text belonging to it.]

184.

OF SIMPLE SHADOWS.



Why, at the intersections a , b of the two compound shadows ef and me , is a simple shadow produced as at eh and mg , while no such simple shadow is produced at the other two intersections cd made by the very same compound shadows?

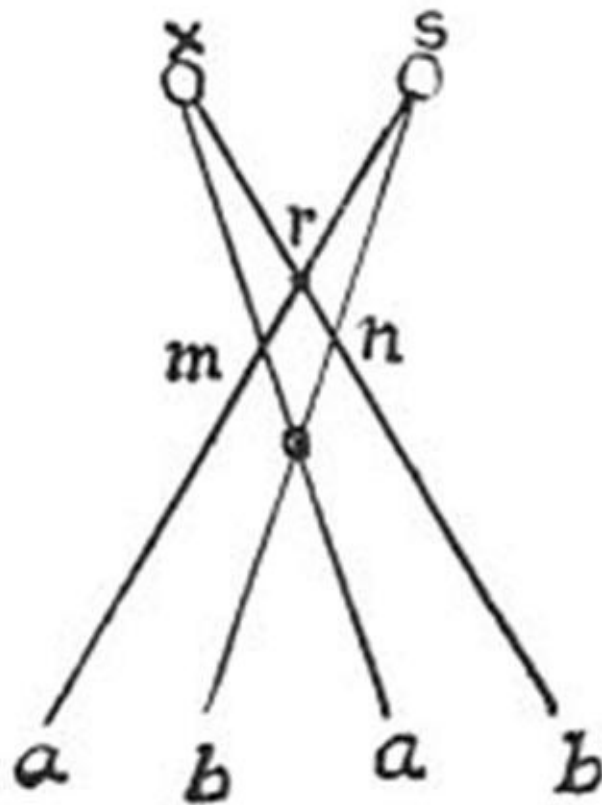
ANSWER.

Compound shadows are a mixture of light and shade and simple shadows are simply darkness. Hence, of the two lights n and o , one falls on the compound

shadow from one side, and the other on the compound shadow from the other side, but where they intersect no light falls, as at *a b*; therefore it is a simple shadow. Where there is a compound shadow one light or the other falls; and here a difficulty arises for my adversary since he says that, where the compound shadows intersect, both the lights which produce the shadows must of necessity fall and therefore these shadows ought to be neutralised; inasmuch as the two lights do not fall there, we say that the shadow is a simple one and where only one of the two lights falls, we say the shadow is compound, and where both the lights fall the shadow is neutralised; for where both lights fall, no shadow of any kind is produced, but only a light background limiting the shadow. Here I shall say that what my adversary said was true: but he only mentions such truths as are in his favour; and if we go on to the rest he must conclude that my proposition is true. And that is: That if both lights fell on the point of intersection, the shadows would be neutralised. This I confess to be true if [neither of] the two shadows fell in the same spot; because, where a shadow and a light fall, a compound shadow is produced, and wherever two shadows or two equal lights fall, the shadow cannot vary in any part of it, the shadows and the lights both being equal. And this is proved in the eighth [proposition] on proportion where it is said that if a given quantity has a single unit of force and resistance, a double quantity will have double force and double resistance.

185.

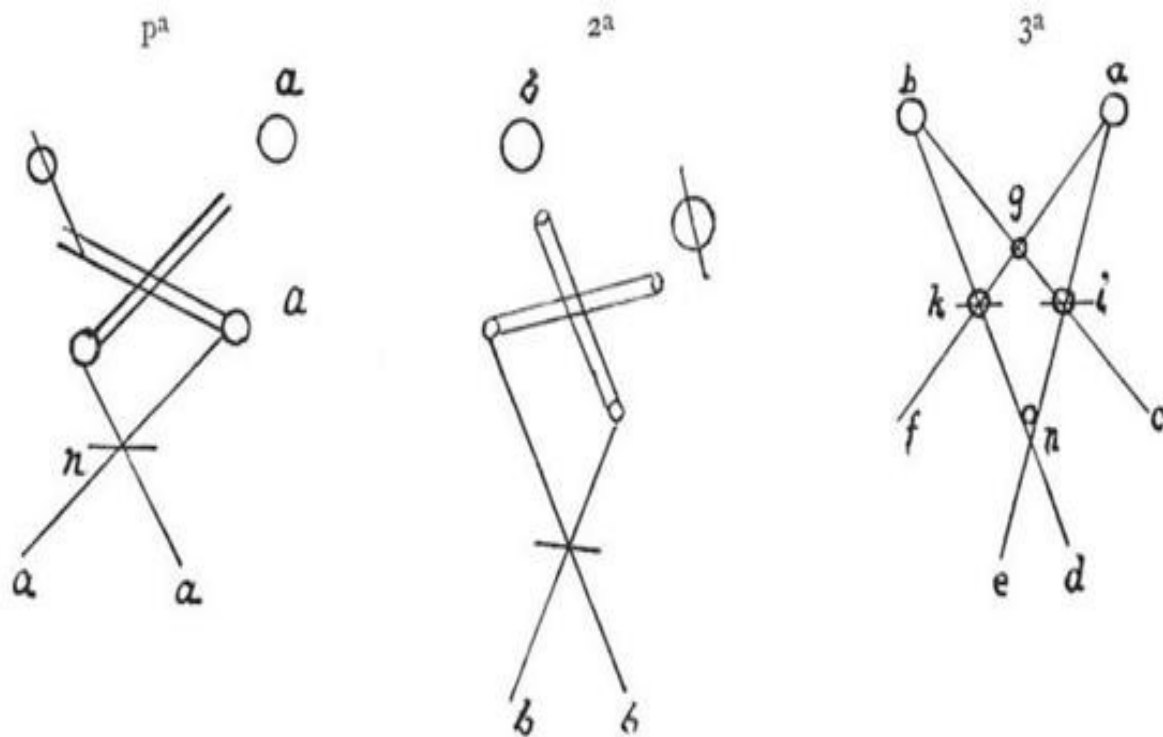
DEFINITION.



The intersection *n* is produced by the shadows caused by the light *b*, because this light *b* produces the shadow *x b*, and the shadow *s b*, but the intersection *m* is produced by the light *a* which causes the shadow *s a*, and the shadow *x a*.

But if you uncover both the lights *a b*, then you get the two shadows *n m* both at once, and besides these, two other, simple shadows are produced at *r o* where neither of the two lights falls at all. The grades of depth in compound shadows are fewer in proportion as the lights falling on, and crossing them are less numerous.

186.



Why the intersections at n being composed of two compound derived shadows, forms a compound shadow and not a simple one, as happens with other intersections of compound shadows. This occurs, according to the 2nd [diagram] of this [prop.] which says: — The intersection of derived shadows when produced by the intersection of columnar shadows caused by a single light does not produce a simple shadow. And this is the corollary of the 1st [prop.] which says: — The intersection of simple derived shadows never results in a deeper shadow, because the deepest shadows all added together cannot be darker than one by itself. Since, if many deepest shadows increased in depth by their duplication, they could not be called the *deepest* shadows, but only part-shadows. But if such intersections are illuminated by a second light placed between the eye and the intersecting bodies, then those shadows would become compound shadows and be uniformly dark just as much at the intersection as throughout the rest. In the 1st and 2nd above, the intersections $i k$ will not be doubled in depth as it is doubled in quantity. But in this 3rd, at the intersections $g n$ they will be double in depth and in quantity.

187.

HOW AND WHEN THE SURROUNDINGS IN SHADOW MINGLE THEIR DERIVED SHADOW WITH THE LIGHT DERIVED FROM THE LUMINOUS BODY.

The derived shadow of the dark walls on each side of the bright light of the window are what mingle their various degrees of shade with the light derived from the window; and these various depths of shade modify every portion of the light, except where it is strongest, at *c*. To prove this let *d a* be the primary shadow which is turned towards the point *e*, and darkens it by its derived shadow; as may be seen by the triangle *a e d*, in which the angle *e* faces the darkened base *d a e*; the point *v* faces the dark shadow *a s* which is part of *a d*, and as the whole is greater than a part, *e* which faces the whole base [of the triangle], will be in deeper shadow than *v* which only faces part of it. In consequence of the conclusion [shown] in the above diagram, *t* will be less darkened than *v*, because the base of the *t* is part of the base of the *v*; and in the same way it follows that *p* is less in shadow than *t*, because the base of the *p* is part of the base of the *t*. And *c* is the terminal point of the derived shadow and the chief beginning of the highest light.

[Footnote: The diagram on Pl. IV, No. 5 belongs to this passage; but it must be noted that the text explains only the figure on the right-hand side.]

FOURTH BOOK ON LIGHT AND SHADE.

On the shape of the cast shadows (188-191).

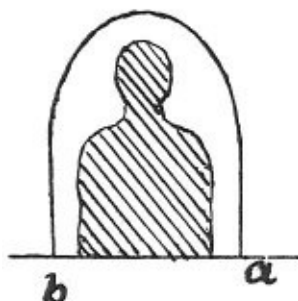
188.

The form of the shadow cast by any body of uniform density can never be the same as that of the body producing it. [Footnote: Comp. the drawing on Pl. XXVIII, No. 5.]

189.

No cast shadow can produce the true image of the body which casts it on a vertical plane unless the centre of the light is equally distant from all the edges of that body.

190.



If a window *a b* admits the sunlight into a room, the sunlight will magnify the size of the window and diminish the shadow of a man in such a way as that when the man makes that dim shadow of himself, approach to that which defines the real size of the window, he will see the shadows where they come into contact, dim and confused from the strength of the light, shutting off and not allowing the solar rays to pass; the effect of the shadow of the man cast by this contact will be exactly that figured above.

[Footnote: It is scarcely possible to render the meaning of this sentence with strict accuracy; mainly because the grammatical construction is defective in the most important part — line 4. In the very slight original sketch the shadow touches the upper arch of the window and the correction, here given is perhaps not justified.]

191.

A shadow is never seen as of uniform depth on the surface which intercepts it unless every portion of that surface is equidistant from the luminous body. This is proved by the 7th which says: — The shadow will appear lighter or stronger as it is surrounded by a darker or a lighter background. And by the 8th of this: — The background will be in parts darker or lighter, in proportion as it is farther

from or nearer to the luminous body. And: — Of various spots equally distant from the luminous body those will always be in the highest light on which the rays fall at the smallest angles: The outline of the shadow as it falls on inequalities in the surface will be seen with all the contours similar to those of the body that casts it, if the eye is placed just where the centre of the light was.

The shadow will look darkest where it is farthest from the body that casts it. The shadow *c d*, cast by the body in shadow *a b* which is equally distant in all parts, is not of equal depth because it is seen on a back ground of varying brightness. [Footnote: Compare the three diagrams on Pl. VI, no 1 which, in the original accompany this section.]

On the outlines of cast shadows (192-195).

192.

The edges of a derived shadow will be most distinct where it is cast nearest to the primary shadow.

193.

As the derived shadow gets more distant from the primary shadow, the more the cast shadow differs from the primary shadow.

194.

OF SHADOWS WHICH NEVER COME TO AN END.

The greater the difference between a light and the body lighted by it, the light being the larger, the more vague will be the outlines of the shadow of that object.

The derived shadow will be most confused towards the edges of its interception by a plane, where it is remotest from the body casting it.

195.

What is the cause which makes the outlines of the shadow vague and confused?

Whether it is possible to give clear and definite outlines to the edges of shadows.

On the relative size of shadows (196. 197).

196.

THE BODY WHICH IS NEAREST TO THE LIGHT CASTS THE LARGEST SHADOW, AND WHY?

If an object placed in front of a single light is very close to it you will see that it casts a very large shadow on the opposite wall, and the farther you remove the object from the light the smaller will the image of the shadow become.

WHY A SHADOW LARGER THAN THE BODY THAT PRODUCES IT BECOMES OUT OF PROPORTION.

The disproportion of a shadow which is larger than the body producing it, results from the light being smaller than the body, so that it cannot be at an equal distance from the edges of the body [Footnote 11: H. LUDWIG in his edition of the old copies, in the Vatican library — in which this chapter is included under Nos. 612, 613 and 614 alters this passage as follows: *quella parte ch'e piu propinqua piu cresce che le distanti*, although the Vatican copy agrees with the original MS. in having *distante* in the former and *propinque* in the latter place. This supposed amendment seems to me to invert the facts. Supposing for instance, that on Pl. XXXI No. 3. *f* is the spot where the light is that illuminates the figure there represented, and that the line behind the figure represents a wall on which the shadow of the figure is thrown. It is evident, that in that case the nearest portion, in this case the under part of the thigh, is very little magnified in

the shadow, and the remoter parts, for instance the head, are more magnified.]; and the portions which are most remote are made larger than the nearer portions for this reason [Footnote 12: See Footnote 11].

WHY A SHADOW WHICH IS LARGER THAN THE BODY CAUSING IT HAS ILL-DEFINED OUTLINES.

The atmosphere which surrounds a light is almost like light itself for brightness and colour; but the farther off it is the more it loses this resemblance. An object which casts a large shadow and is near to the light, is illuminated both by that light by the luminous atmosphere; hence this diffused light gives the shadow ill-defined edges.

197.

A luminous body which is long and narrow in shape gives more confused outlines to the derived shadow than a spherical light, and this contradicts the proposition next following: A shadow will have its outlines more clearly defined in proportion as it is nearer to the primary shadow or, I should say, the body casting the shadow; [Footnote 14: The lettering refers to the lower diagram, Pl. XLI, No. 5.] the cause of this is the elongated form of the luminous body *a c*, &c. [Footnote 16: See Footnote 14].

Effects on cast shadows by the tone of the back ground.

198.

OF MODIFIED SHADOWS.

Modified shadows are those which are cast on light walls or other illuminated objects.

A shadow looks darkest against a light background. The outlines of a derived shadow will be clearer as they are nearer to the primary shadow. A derived

shadow will be most defined in shape where it is intercepted, where the plane intercepts it at the most equal angle.

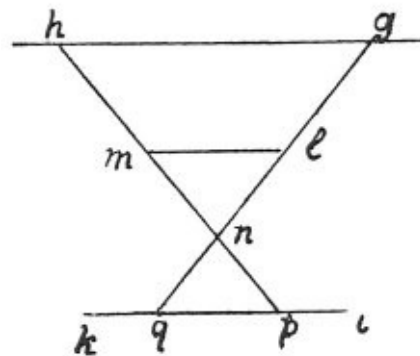
Those parts of a shadow will appear darkest which have darker objects opposite to them. And they will appear less dark when they face lighter objects. And the larger the light object opposite, the more the shadow will be lightened.

And the larger the surface of the dark object the more it will darken the derived shadow where it is intercepted.

A disputed proposition.

199.

OF THE OPINION OF SOME THAT A TRIANGLE CASTS NO SHADOW ON A PLANE SURFACE.



Certain mathematicians have maintained that a triangle, of which the base is turned to the light, casts no shadow on a plane; and this they prove by saying that no spherical body smaller than the light can reach the middle with the shadow. The lines of radiant light are straight lines ; therefore, suppose the light to be $g h$ and the triangle $l m n$, and let the plane be $i k$; they say the light g falls on the side of the triangle $l n$, and the portion of the plane $i q$. Thus again h like g falls on the side $l m$, and then on $m n$ and the plane $p k$; and if the whole plane thus faces the lights $g h$, it is evident that the triangle has no shadow; and that which has no shadow can cast none. This, in this case appears credible. But if the triangle $n p g$ were not illuminated by the two lights g and h , but by $i p$ and g and k neither side is lighted by more than one single light: that is $i p$ is invisible to h g and k will never be lighted by g ; hence $p q$ will be twice as light as the two visible portions that are in shadow.

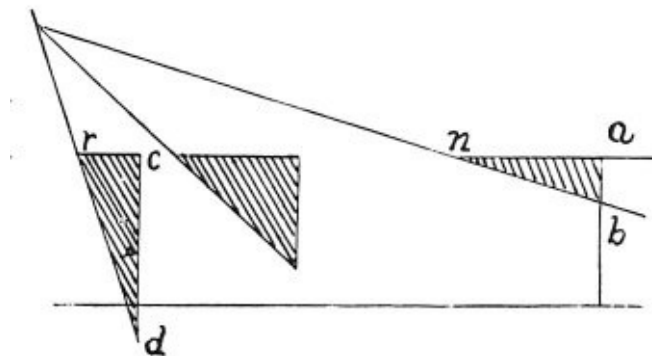
[Footnote: 5 — 6. This passage is so obscure that it would be rash to offer an

explanation. Several words seem to have been omitted.]
On the relative depth of cast shadows (200-202).

200.

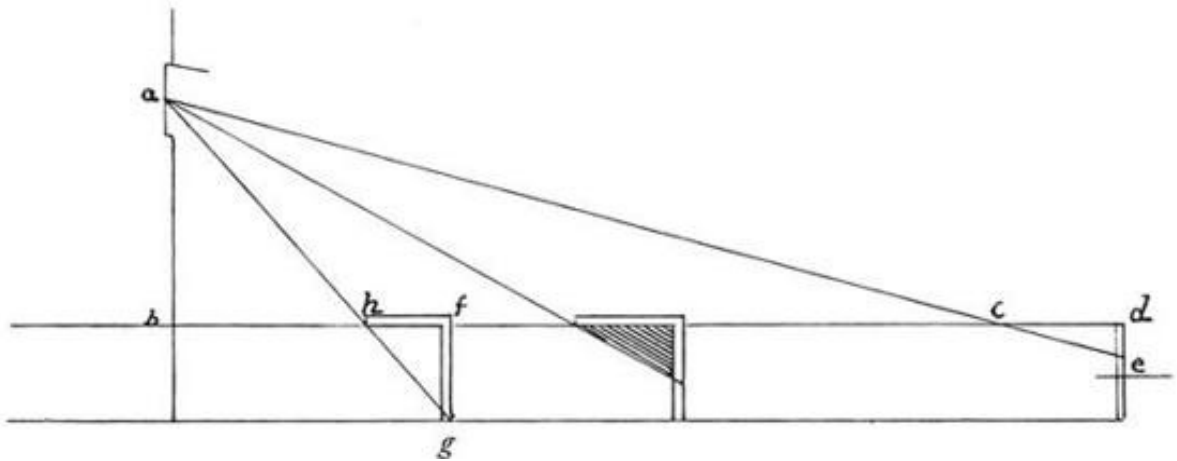
A spot is most in the shade when a large number of darkened rays fall upon it. The spot which receives the rays at the widest angle and by darkened rays will be most in the dark; *a* will be twice as dark as *b*, because it originates from twice as large a base at an equal distance. A spot is most illuminated when a large number of luminous rays fall upon it. *d* is the beginning of the shadow *d f*, and tinges *c* but *a* little; *d e* is half of the shadow *d f* and gives a deeper tone where it is cast at *b* than at *f*. And the whole shaded space *e* gives its tone to the spot *a*. [Footnote: The diagram here referred to is on Pl. XLI, No. 2.]

201.



A n will be darker than *c r* in proportion to the number of times that *a b* goes into *c d*.

202.



The shadow cast by an object on a plane will be smaller in proportion as that object is lighted by feebler rays. Let $d e$ be the object and $d c$ the plane surface; the number of times that $d e$ will go into $f g$ gives the proportion of light at $f h$ to $d c$. The ray of light will be weaker in proportion to its distance from the hole through which it falls.

FIFTH BOOK ON LIGHT AND SHADE.

Principles of reflection (203. 204).

203.

OF THE WAY IN WHICH THE SHADOWS CAST BY OBJECTS OUGHT TO BE DEFINED.

If the object is the mountain here figured, and the light is at the point a , I say that from $b d$ and also from $c f$ there will be no light but from reflected rays. And this results from the fact that rays of light can only act in straight lines; and the same is the case with the secondary or reflected rays.

204.

The edges of the derived shadow are defined by the hues of the illuminated objects surrounding the luminous body which produces the shadow.

On reverberation.

205.

OF REVERBERATION.

Reverberation is caused by bodies of a bright nature with a flat and semi opaque surface which, when the light strikes upon them, throw it back again, like the rebound of a ball, to the former object.

WHERE THERE CAN BE NO REFLECTED LIGHTS.

All dense bodies have their surfaces occupied by various degrees of light and shade. The lights are of two kinds, one called original, the other borrowed. Original light is that which is inherent in the flame of fire or the light of the sun or of the atmosphere. Borrowed light will be reflected light; but to return to the promised definition: I say that this luminous reverberation is not produced by those portions of a body which are turned towards darkened objects, such as shaded spots, fields with grass of various height, woods whether green or bare; in which, though that side of each branch which is turned towards the original light has a share of that light, nevertheless the shadows cast by each branch separately are so numerous, as well as those cast by one branch on the others, that finally so much shadow is the result that the light counts for nothing. Hence objects of this kind cannot throw any reflected light on opposite objects.

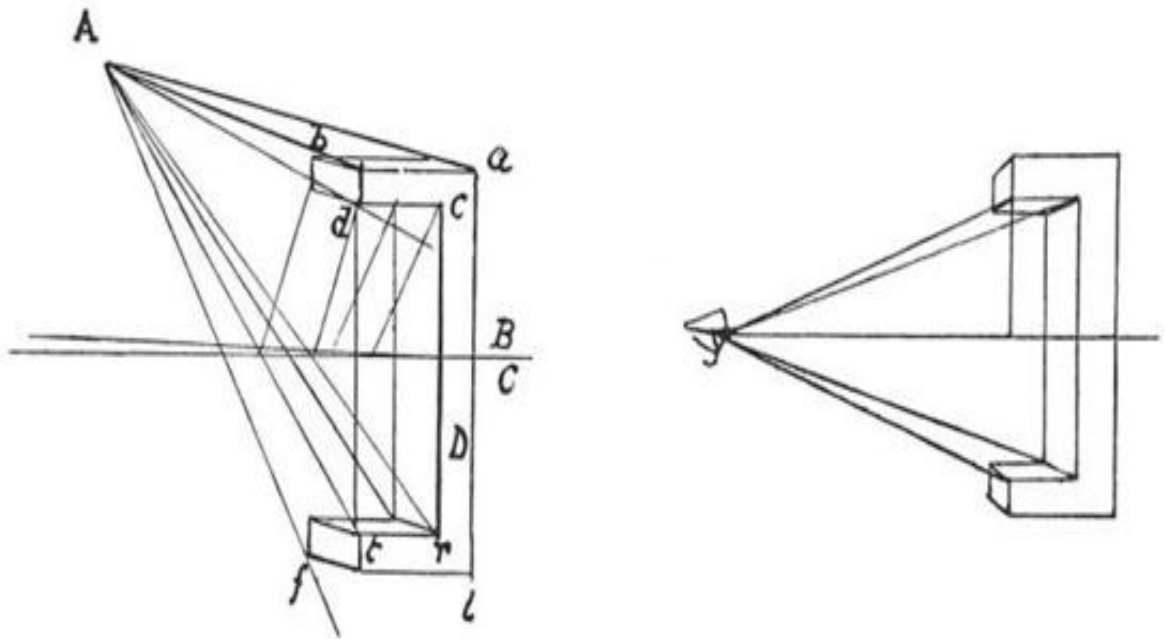
Reflection on water (206. 207).

206.

PERSPECTIVE.

The shadow or object mirrored in water in motion, that is to say in small wavelets, will always be larger than the external object producing it.

207.



It is impossible that an object mirrored on water should correspond in form to the object mirrored, since the centre of the eye is above the surface of the water.

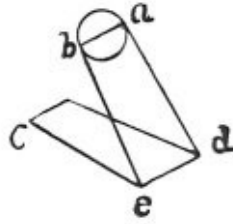
This is made plain in the figure here given, which demonstrates that the eye sees the surface *a b*, and cannot see it at *l f*, and at *r t*; it sees the surface of the image at *r t*, and does not see it in the real object *c d*. Hence it is impossible to see it, as has been said above unless the eye itself is situated on the surface of the water as is shown below .

[Footnote: *A* stands for *ochio* [eye], *B* for *aria* [air], *C* for *acqua* [water], *D* for *cateto* [cathetus]. — In the original MS. the second diagram is placed below line 13.]

Experiments with the mirror (208-210).

208.

THE MIRROR.

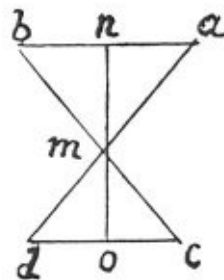


If the illuminated object is of the same size as the luminous body and as that in which the light is reflected, the amount of the reflected light will bear the same proportion to the intermediate light as this second light will bear to the first, if both bodies are smooth and white.

209.

Describe how it is that no object has its limitation in the mirror but in the eye which sees it in the mirror. For if you look at your face in the mirror, the part resembles the whole in as much as the part is everywhere in the mirror, and the whole is in every part of the same mirror; and the same is true of the whole image of any object placed opposite to this mirror, &c.

210.



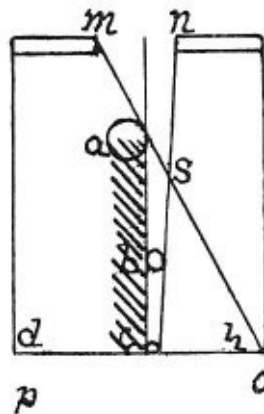
No man can see the image of another man in a mirror in its proper place with regard to the objects; because every object falls on [the surface of] the mirror at equal angles. And if the one man, who sees the other in the mirror, is not in a direct line with the image he will not see it in the place where it really falls; and if he gets into the line, he covers the other man and puts himself in the place occupied by his image. Let no be the mirror, b the eye of your friend and d your own eye. Your friend's eye will appear to you at a , and to him it will seem that yours is at c , and the intersection of the visual rays will occur at m , so that either of you touching m will touch the eye of the other man which shall be open. And if you touch the eye of the other man in the mirror it will seem to him that you

are touching your own.

Appendix: — On shadows in movement (211. 212).

211.

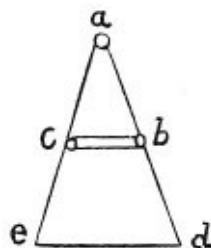
OF THE SHADOW AND ITS MOTION.



When two bodies casting shadows, and one in front of the other, are between a window and the wall with some space between them, the shadow of the body which is nearest to the plane of the wall will move if the body nearest to the window is put in transverse motion across the window. To prove this let *a* and *b* be two bodies placed between the window *n m* and the plane surface *o p* with sufficient space between them as shown by the space *a b*. I say that if the body *a* is moved towards *s* the shadow of the body *b* which is at *c* will move towards *d*.

212.

OF THE MOTION OF SHADOWS.



The motion of a shadow is always more rapid than that of the body which

produces it if the light is stationary. To prove this let a be the luminous body, and b the body casting the shadow, and d the shadow. Then I say that in the time while the solid body moves from b to c , the shadow d will move to e ; and this proportion in the rapidity of the movements made in the same space of time, is equal to that in the length of the space moved over. Thus, given the proportion of the space moved over by the body b to c , to that moved over by the shadow d to e , the proportion in the rapidity of their movements will be the same.

But if the luminous body is also in movement with a velocity equal to that of the solid body, then the shadow and the body that casts it will move with equal speed. And if the luminous body moves more rapidly than the solid body, the motion of the shadow will be slower than that of the body casting it.

But if the luminous body moves more slowly than the solid body, then the shadow will move more rapidly than that body.

SIXTH BOOK ON LIGHT AND SHADE.

The effect of rays passing through holes (213. 214).

213.

PERSPECTIVE.

If you transmit the rays of the sun through a hole in the shape of a star you will see a beautiful effect of perspective in the spot where the sun's rays fall.

[Footnote: In this and the following chapters of MS. C the order of the original paging has been adhered to, and is shown in parenthesis. Leonardo himself has but rarely worked out the subject of these propositions. The space left for the purpose has occasionally been made use of for quite different matter. Even the numerous diagrams, most of them very delicately sketched, lettered and numbered, which occur on these pages, are hardly ever explained, with the exception of those few which are here given.]

214.

No small hole can so modify the convergence of rays of light as to prevent, at a long distance, the transmission of the true form of the luminous body causing them. It is impossible that rays of light passing through a parallel [slit], should not display the form of the body causing them, since all the effects produced by a luminous body are [in fact] the reflection of that body: The moon, shaped like a boat, if transmitted through a hole is figured in the surface [it falls on] as a boatshaped object. [Footnote 8: In the MS. a blank space is left after this question.] Why the eye sees bodies at a distance, larger than they measure on the vertical plane?.

[Footnote: This chapter, taken from another MS. may, as an exception, be placed here, as it refers to the same subject as the preceding section.]

On gradation of shadows (215. 216).

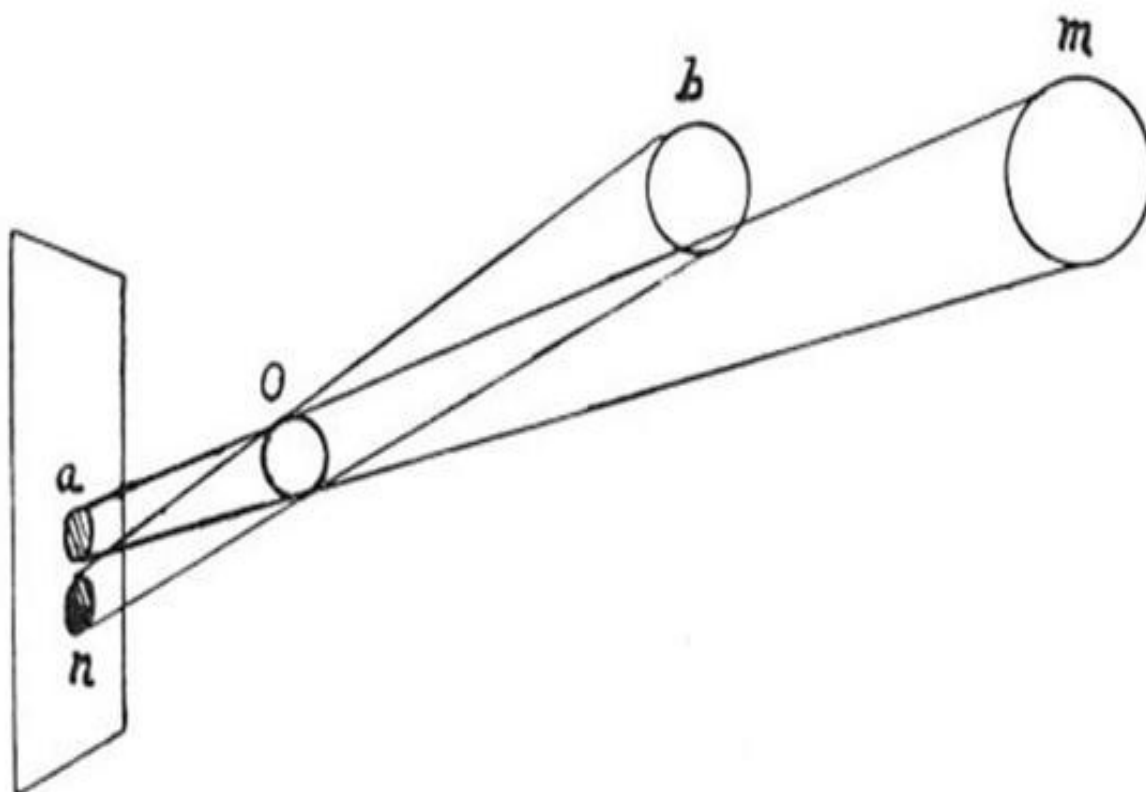
215.

Although the breadth and length of lights and shadow will be narrower and shorter in foreshortening, the quality and quantity of the light and shade is not increased nor diminished.

The function of shade and light when diminished by foreshortening, will be to give shadow and to illuminate an object opposite, according to the quality and quantity in which they fall on the body.

In proportion as a derived shadow is nearer to its penultimate extremities the deeper it will appear, $g z$ beyond the intersection faces only the part of the shadow [marked] $y z$; this by intersection takes the shadow from $m n$ but by direct line it takes the shadow $a m$ hence it is twice as deep as $g z$. $Y x$, by intersection takes the shadow $n o$, but by direct line the shadow $n m a$, therefore $x y$ is three times as dark as $z g$; $x f$, by intersection faces $o b$ and by direct line $o n m a$, therefore we must say that the shadow between $f x$ will be four times as dark as the shadow $z g$, because it faces four times as much shadow.

Let $a b$ be the side where the primary shadow is, and $b c$ the primary light, d will be the spot where it is intercepted, $f g$ the derived shadow and $f e$ the derived light.



And this must be at the beginning of the explanation.

[Footnote: In the original MS. the text of No. 252 precedes the one given here. In the text of No. 215 there is a blank space of about four lines between the lines 2 and 3. The diagram given on Pl. VI, No. 2 is placed between lines 4 and 5. Between lines 5 and 6 there is another space of about three lines and one line left blank between lines 8 and 9. The reader will find the meaning of the whole passage much clearer if he first reads the final lines 11 — 13. Compare also line 4 of No. 270.]

On relative proportion of light and shadows (216 — 221).

216.

That part of the surface of a body on which the images [reflection] from other bodies placed opposite fall at the largest angle will assume their hue most strongly. In the diagram below, 8 is a larger angle than 4, since its base $a n$ is larger than $e n$ the base of 4. This diagram below should end at $a n 4 8$. That portion of the illuminated surface on which a shadow is cast will be brightest which lies contiguous to the cast shadow. Just as an object which is lighted up by

a greater quantity of luminous rays becomes brighter, so one on which a greater quantity of shadow falls, will be darker.

Let 4 be the side of an illuminated surface 4 8, surrounding the cast shadow *g e* 4. And this spot 4 will be lighter than 8, because less shadow falls on it than on 8. Since 4 faces only the shadow *i n*; and 8 faces and receives the shadow *a e* as well as *i n* which makes it twice as dark. And the same thing happens when you put the atmosphere and the sun in the place of shade and light.

The distribution of shadow, originating in, and limited by, plane surfaces placed near to each other, equal in tone and directly opposite, will be darker at the ends than at the beginning, which will be determined by the incidence of the luminous rays. You will find the same proportion in the depth of the derived shadows *a n* as in the nearness of the luminous bodies *m b*, which cause them; and if the luminous bodies were of equal size you would still farther find the same proportion in the light cast by the luminous circles and their shadows as in the distance of the said luminous bodies.

[Footnote: The diagram originally placed between lines 3 and 4 is on Pl. VI, No. 3. In the diagram given above line 14 of the original, and here printed in the text, the words *corpo luminoso* [luminous body] are written in the circle *m*, *luminoso* in the circle *b* and *ombroso* [body in shadow] in the circle *o*.]

217.

THAT PART OF THE REFLECTION WILL BE BRIGHTEST WHERE THE REFLECTED RAYS ARE SHORTEST.

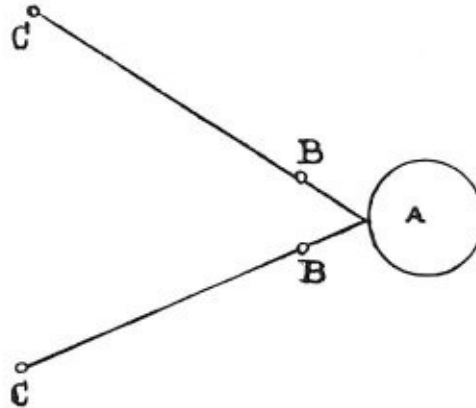
The darkness occasioned by the casting of combined shadows will be in conformity with its cause, which will originate and terminate between two plane surfaces near together, alike in tone and directly opposite each other.

In proportion as the source of light is larger, the luminous and shadow rays will be more mixed together. This result is produced because wherever there is a larger quantity of luminous rays, there is most light, but where there are fewer there is least light, consequently the shadow rays come in and mingle with them.

[Footnote: Diagrams are inserted before lines 2 and 4.]

218.

In all the proportions I lay down it must be understood that the medium between the bodies is always the same. The smaller the luminous body the more distinct will the transmission of the shadows be.



When of two opposite shadows, produced by the same body, one is twice as dark as the other though similar in form, one of the two lights causing them must have twice the diameter that the other has and be at twice the distance from the opaque body. If the object is lowly moved across the luminous body, and the shadow is intercepted at some distance from the object, there will be the same relative proportion between the motion of the derived shadow and the motion of the primary shadow, as between the distance from the object to the light, and that from the object to the spot where the shadow is intercepted; so that though the object is moved slowly the shadow moves fast.

[Footnote: There are diagrams inserted before lines 2 and 3 but they are not reproduced here. The diagram above line 6 is written upon as follows: at *A lume* (light), at *B obbietto* (body), at *C ombra d'obbietto* (shadow of the object).]

219.

A luminous body will appear less brilliant when surrounded by a bright background.

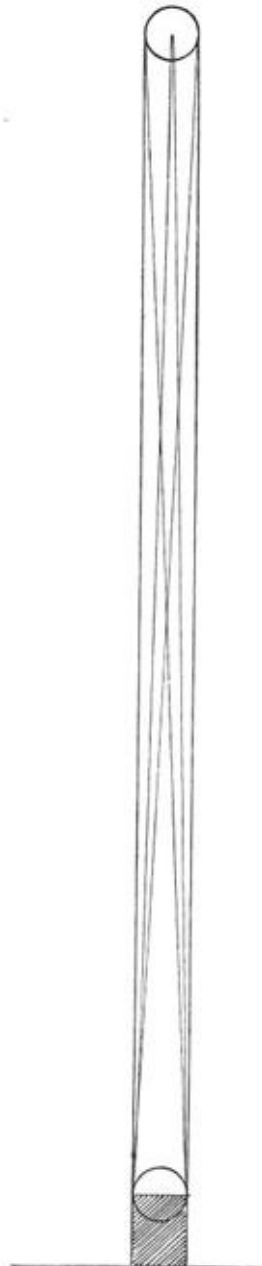
I have found that the stars which are nearest to the horizon look larger than the others because light falls upon them from a larger proportion of the solar body than when they are above us; and having more light from the sun they give more light, and the bodies which are most luminous appear the largest. As may be seen by the sun through a mist, and overhead; it appears larger where there is

no mist and diminished through mist. No portion of the luminous body is ever visible from any spot within the pyramid of pure derived shadow.

[Footnote: Between lines 1 and 2 there is in the original a large diagram which does not refer to this text.]

220.

A body on which the solar rays fall between the thin branches of trees far apart will cast but a single shadow.



If an opaque body and a luminous one are (both) spherical the base of the pyramid of rays will bear the same proportion to the luminous body as the base of the pyramid of shade to the opaque body.

When the transmitted shadow is intercepted by a plane surface placed opposite to it and farther away from the luminous body than from the object [which casts it] it will appear proportionately darker and the edges more distinct.

[Footnote: The diagram which, in the original, is placed above line 2, is similar to the one, here given on page 73 (section 120). — The diagram here given in the margin stands, in the original, between lines 3 and 4.]

221.

A body illuminated by the solar rays passing between the thick branches of trees will produce as many shadows as there are branches between the sun and itself.

Where the shadow-rays from an opaque pyramidal body are intercepted they will cast a shadow of bifurcate outline and various depth at the points. A light which is broader than the apex but narrower than the base of an opaque pyramidal body placed in front of it, will cause that pyramid to cast a shadow of bifurcate form and various degrees of depth.

If an opaque body, smaller than the light, casts two shadows and if it is the same size or larger, casts but one, it follows that a pyramidal body, of which part is smaller, part equal to, and part larger than, the luminous body, will cast a bifurcate shadow.

[Footnote: Between lines 2 and 3 there are in the original two large diagrams.]

IV. PERSPECTIVE OF DISAPPEARANCE.

The theory of the “Prospettiva de’ perdimenti” would, in many important details, be quite unintelligible if it had not been led up by the principles of light and shade on which it is based. The word “Prospettiva” in the language of the time included the principles of optics; what Leonardo understood by “Perdimenti” will be clearly seen in the early chapters, Nos. 222 — 224. It is in the very nature of the case that the farther explanations given in the subsequent chapters must be limited to general rules. The sections given as 227 — 231 “On indistinctness at short distances” have, it is true, only an indirect bearing on the subject; but on the other hand, the following chapters, 232 — 234, “On indistinctness at great distances,” go fully into the matter, and in chapters 235 — 239, which treat “Of the importance of light and shade in the Perspective of Disappearance”, the practical issues are distinctly insisted on in their relation to the theory. This is naturally followed by the statements as to “the effect of light or dark backgrounds on the apparent size of bodies” (Nos. 240 — 250). At the end I have placed, in the order of the original, those sections from the MS. C which treat of the “Perspective of Disappearance” and serve to some extent to complete the treatment of the subject (251 — 262).

Definition (222. 223).

222.

OF THE DIMINISHED DISTINCTNESS OF THE OUTLINES OF OPAQUE BODIES.

If the real outlines of opaque bodies are indistinguishable at even a very short distance, they will be more so at long distances; and, since it is by its outlines that we are able to know the real form of any opaque body, when by its remoteness we fail to discern it as a whole, much more must we fail to discern its parts and outlines.

223.

OF THE DIMINUTION IN PERSPECTIVE OF OPAQUE OBJECTS.

Among opaque objects of equal size the apparent diminution of size will be in proportion to their distance from the eye of the spectator; but it is an inverse proportion, since, where the distance is greater, the opaque body will appear smaller, and the less the distance the larger will the object appear. And this is the fundamental principle of linear perspective and it follows: — every object as it becomes more remote loses first those parts which are smallest. Thus of a horse, we should lose the legs before the head, because the legs are thinner than the head; and the neck before the body for the same reason. Hence it follows that the last part of the horse which would be discernible by the eye would be the mass of the body in an oval form, or rather in a cylindrical form and this would lose its apparent thickness before its length — according to the 2nd rule given above, &c. [Footnote 23: Compare line 11.].

If the eye remains stationary the perspective terminates in the distance in a point. But if the eye moves in a straight [horizontal] line the perspective terminates in a line and the reason is that this line is generated by the motion of the point and our sight; therefore it follows that as we move our sight [eye], the point moves, and as we move the point, the line is generated, &c.

An illustration by experiment.

224.

Every visible body, in so far as it affects the eye, includes three attributes; that is to say: mass, form and colour; and the mass is recognisable at a greater distance from the place of its actual existence than either colour or form. Again, colour is discernible at a greater distance than form, but this law does not apply to luminous bodies.

The above proposition is plainly shown and proved by experiment; because: if you see a man close to you, you discern the exact appearance of the mass and of the form and also of the colouring; if he goes to some distance you will not recognise who he is, because the character of the details will disappear, if he goes still farther you will not be able to distinguish his colouring, but he will

appear as a dark object, and still farther he will appear as a very small dark rounded object. It appears rounded because distance so greatly diminishes the various details that nothing remains visible but the larger mass. And the reason is this: We know very well that all the images of objects reach the senses by a small aperture in the eye; hence, if the whole horizon *a d* is admitted through such an aperture, the object *b c* being but a very small fraction of this horizon what space can it fill in that minute image of so vast a hemisphere? And because luminous bodies have more power in darkness than any others, it is evident that, as the chamber of the eye is very dark, as is the nature of all colored cavities, the images of distant objects are confused and lost in the great light of the sky; and if they are visible at all, appear dark and black, as every small body must when seen in the diffused light of the atmosphere.

[Footnote: The diagram belonging to this passage is placed between lines 5 and 6; it is No. 4 on Pl. VI.]

A guiding rule.

225.

OF THE ATMOSPHERE THAT INTERPOSES BETWEEN THE EYE AND VISIBLE OBJECTS.

An object will appear more or less distinct at the same distance, in proportion as the atmosphere existing between the eye and that object is more or less clear. Hence, as I know that the greater or less quantity of the air that lies between the eye and the object makes the outlines of that object more or less indistinct, you must diminish the definiteness of outline of those objects in proportion to their increasing distance from the eye of the spectator.

An experiment.

226.

When I was once in a place on the sea, at an equal distance from the shore and the mountains, the distance from the shore looked much greater than that from the mountains.

On indistinctness at short distances (227-231).

227.

If you place an opaque object in front of your eye at a distance of four fingers' breadth, if it is smaller than the space between the two eyes it will not interfere with your seeing any thing that may be beyond it. No object situated beyond another object seen by the eye can be concealed by this [nearer] object if it is smaller than the space from eye to eye.

228.

The eye cannot take in a luminous angle which is too close to it.

229.

That part of a surface will be better lighted on which the light falls at the greater angle. And that part, on which the shadow falls at the greatest angle, will receive from those rays least of the benefit of the light.

230.

OF THE EYE.

The edges of an object placed in front of the pupil of the eye will be less distinct in proportion as they are closer to the eye. This is shown by the edge of the object *n* placed in front of the pupil *d*; in looking at this edge the pupil also sees all the space *a c* which is beyond the edge; and the images the eye receives from that space are mingled with the images of the edge, so that one image confuses the other, and this confusion hinders the pupil from distinguishing the edge.

231.

The outlines of objects will be least clear when they are nearest to the eye, and therefore remoter outlines will be clearer. Among objects which are smaller than the pupil of the eye those will be less distinct which are nearer to the eye.

On indistinctness at great distances (232-234).

232.

Objects near to the eye will appear larger than those at a distance.

Objects seen with two eyes will appear rounder than if they are seen with only one.

Objects seen between light and shadow will show the most relief.

233.

OF PAINTING.

Our true perception of an object diminishes in proportion as its size is diminished by distance.

234.

PERSPECTIVE.

Why objects seen at a distance appear large to the eye and in the image on the vertical plane they appear small.

PERSPECTIVE.

I ask how far away the eye can discern a non-luminous body, as, for instance, a mountain. It will be very plainly visible if the sun is behind it; and could be seen at a greater or less distance according to the sun's place in the sky.

[Footnote: The clue to the solution of this problem (lines 1-3) is given in lines 4-6, No. 232. Objects seen with both eyes appear solid since they are seen from two distinct points of sight separated by the distance between the eyes, but this solidity cannot be represented in a flat drawing. Compare No. 535.]

The importance of light and shade in the perspective of disappearance (235-239).

235.

An opaque body seen in a line in which the light falls will reveal no prominences to the eye. For instance, let a be the solid body and c the light; $c m$ and $c n$ will be the lines of incidence of the light, that is to say the lines which transmit the light to the object a . The eye being at the point b , I say that since the light c falls on the whole part $m n$ the portions in relief on that side will all be illuminated. Hence the eye placed at c cannot see any light and shade and, not seeing it, every portion will appear of the same tone, therefore the relief in the prominent or rounded parts will not be visible.

236.

OF PAINTING.

When you represent in your work shadows which you can only discern with difficulty, and of which you cannot distinguish the edges so that you apprehend them confusedly, you must not make them sharp or definite lest your work should have a wooden effect.

237.

OF PAINTING.

You will observe in drawing that among the shadows some are of

undistinguishable gradation and form, as is shown in the 3rd [proposition] which says: Rounded surfaces display as many degrees of light and shade as there are varieties of brightness and darkness reflected from the surrounding objects.

238.

OF LIGHT AND SHADE.

You who draw from nature, look (carefully) at the extent, the degree, and the form of the lights and shadows on each muscle; and in their position lengthwise observe towards which muscle the axis of the central line is directed.

239.

An object which is [so brilliantly illuminated as to be] almost as bright as light will be visible at a greater distance, and of larger apparent size than is natural to objects so remote.

The effect of light or dark backgrounds on the apparent size of objects (240-250).

240.

A shadow will appear dark in proportion to the brilliancy of the light surrounding it and conversely it will be less conspicuous where it is seen against a darker background.

241.

OF ORDINARY PERSPECTIVE.

An object of equal breadth and colour throughout, seen against a background of

various colours will appear unequal in breadth.

And if an object of equal breadth throughout, but of various colours, is seen against a background of uniform colour, that object will appear of various breadth. And the more the colours of the background or of the object seen against the ground vary, the greater will the apparent variations in the breadth be though the objects seen against the ground be of equal breadth [throughout].

242.

A dark object seen against a bright background will appear smaller than it is.

A light object will look larger when it is seen against a background darker than itself.

243.

OF LIGHT.

A luminous body when obscured by a dense atmosphere will appear smaller; as may be seen by the moon or sun veiled by mists.

OF LIGHT.

Of several luminous bodies of equal size and brilliancy and at an equal distance, that will look the largest which is surrounded by the darkest background.

OF LIGHT.

I find that any luminous body when seen through a dense and thick mist diminishes in proportion to its distance from the eye. Thus it is with the sun by day, as well as the moon and the other eternal lights by night. And when the air is clear, these luminaries appear larger in proportion as they are farther from the eye.

244.

That portion of a body of uniform breadth which is against a lighter background will look narrower [than the rest].

e is a given object, itself dark and of uniform breadth; *a b* and *c d* are two backgrounds one darker than the other; *b c* is a bright background, as it might be a spot lighted by the sun through an aperture in a dark room. Then I say that the object *e g* will appear larger at *e f* than at *g h*; because *e f* has a darker background than *g h*; and again at *f g* it will look narrower from being seen by the eye *o*, on the light background *b c*. [Footnote 12: The diagram to which the text, lines 1-11, refers, is placed in the original between lines 3 and 4, and is given on Pl. XLI, No. 3. Lines 12 to 14 are explained by the lower of the two diagrams on Pl. XLI, No. 4. In the original these are placed after line 14.] That part of a luminous body, of equal breadth and brilliancy throughout, will look largest which is seen against the darkest background; and the luminous body will seem on fire.

245.

WHY BODIES IN LIGHT AND SHADE HAVE THEIR OUTLINES ALTERED BY THE COLOUR AND BRIGHTNESS OF THE OBJECTS SERVING AS A BACKGROUND TO THEM.

If you look at a body of which the illuminated portion lies and ends against a dark background, that part of the light which will look brightest will be that which lies against the dark [background] at *d*. But if this brighter part lies against a light background, the edge of the object, which is itself light, will be less distinct than before, and the highest light will appear to be between the limit of the background *m f* and the shadow. The same thing is seen with regard to the dark [side], inasmuch as that edge of the shaded portion of the object which lies against a light background, as at *l*, it looks much darker than the rest. But if this shadow lies against a dark background, the edge of the shaded part will appear

lighter than before, and the deepest shade will appear between the edge and the light at the point *o*.

[Footnote: In the original diagram *o* is inside the shaded surface at the level of *d*.]

246.

An opaque body will appear smaller when it is surrounded by a highly luminous background, and a light body will appear larger when it is seen against a darker background. This may be seen in the height of buildings at night, when lightning flashes behind them; it suddenly seems, when it lightens, as though the height of the building were diminished. For the same reason such buildings look larger in a mist, or by night than when the atmosphere is clear and light.

247.

ON LIGHT BETWEEN SHADOWS

When you are drawing any object, remember, in comparing the grades of light in the illuminated portions, that the eye is often deceived by seeing things lighter than they are. And the reason lies in our comparing those parts with the contiguous parts. Since if two [separate] parts are in different grades of light and if the less bright is conterminous with a dark portion and the brighter is conterminous with a light background — as the sky or something equally bright — , then that which is less light, or I should say less radiant, will look the brighter and the brighter will seem the darker.

248.

Of objects equally dark in themselves and situated at a considerable and equal distance, that will look the darkest which is farthest above the earth.

249.

TO PROVE HOW IT IS THAT LUMINOUS BODIES APPEAR LARGER, AT A DISTANCE, THAN THEY ARE.

If you place two lighted candles side by side half a braccio apart, and go from them to a distance 200 braccia you will see that by the increased size of each they will appear as a single luminous body with the light of the two flames, one braccio wide.

TO PROVE HOW YOU MAY SEE THE REAL SIZE OF LUMINOUS BODIES.

If you wish to see the real size of these luminous bodies, take a very thin board and make in it a hole no bigger than the tag of a lace and place it as close to your eye as possible, so that when you look through this hole, at the said light, you can see a large space of air round it. Then by rapidly moving this board backwards and forwards before your eye you will see the light increase [and diminish].

Propositions on perspective of disappearance from MS. C. (250-262).

250.

Of several bodies of equal size and equally distant from the eye, those will look the smallest which are against the lightest background.

Every visible object must be surrounded by light and shade. A perfectly spherical body surrounded by light and shade will appear to have one side larger than the other in proportion as one is more highly lighted than the other.

251.

PERSPECTIVE.

No visible object can be well understood and comprehended by the human eye excepting from the difference of the background against which the edges of the object terminate and by which they are bounded, and no object will appear [to stand out] separate from that background so far as the outlines of its borders are concerned. The moon, though it is at a great distance from the sun, when, in an eclipse, it comes between our eyes and the sun, appears to the eyes of men to be close to the sun and affixed to it, because the sun is then the background to the moon.

252.

A luminous body will appear more brilliant in proportion as it is surrounded by deeper shadow. [Footnote: The diagram which, in the original, is placed after this text, has no connection with it.]

253.

The straight edges of a body will appear broken when they are conterminous with a dark space streaked with rays of light. [Footnote: Here again the diagrams in the original have no connection with the text.]

254.

Of several bodies, all equally large and equally distant, that which is most brightly illuminated will appear to the eye nearest and largest. [Footnote: Here again the diagrams in the original have no connection with the text.]

255.

If several luminous bodies are seen from a great distance although they are really separate they will appear united as one body.

256.

If several objects in shadow, standing very close together, are seen against a bright background they will appear separated by wide intervals.

257.

Of several bodies of equal size and tone, that which is farthest will appear the lightest and smallest.

258.

Of several objects equal in size, brightness of background and length that which has the flattest surface will look the largest. A bar of iron equally thick throughout and of which half is red hot, affords an example, for the red hot part looks thicker than the rest.

259.

Of several bodies of equal size and length, and alike in form and in depth of shade, that will appear smallest which is surrounded by the most luminous background.

260.

**DIFFERENT PORTIONS OF A WALL SURFACE
WILL BE DARKER OR BRIGHTER IN
PROPORTION AS THE LIGHT OR SHADOW
FALLS ON THEM AT A LARGER ANGLE.**

The foregoing proposition can be clearly proved in this way. Let us say that $m q$ is the luminous body, then $f g$ will be the opaque body; and let $a e$ be the above-mentioned plane on which the said angles fall, showing [plainly] the nature and character of their bases. Then: a will be more luminous than b ; the base of the

angle a is larger than that of b and it therefore makes a greater angle which will be $a m q$; and the pyramid $b p m$ will be narrower and $m o c$ will be still finer, and so on by degrees, in proportion as they are nearer to e , the pyramids will become narrower and darker. That portion of the wall will be the darkest where the breadth of the pyramid of shadow is greater than the breadth of the pyramid of light.

At the point a the pyramid of light is equal in strength to the pyramid of shadow, because the base $f g$ is equal to the base $r f$. At the point d the pyramid of light is narrower than the pyramid of shadow by so much as the base $s f$ is less than the base $f g$.

Divide the foregoing proposition into two diagrams, one with the pyramids of light and shadow, the other with the pyramids of light [only].

261.

Among shadows of equal depth those which are nearest to the eye will look least deep.

262.

The more brilliant the light given by a luminous body, the deeper will the shadows be cast by the objects it illuminates.

V. THEORY OF COLOURS.

Leonardo's theory of colours is even more intimately connected with his principles of light and shade than his Perspective of Disappearance and is in fact merely an appendix or supplement to those principles, as we gather from the titles to sections 264, 267, and 276, while others again (Nos. 281, 282) are headed Prospettiva.

A very few of these chapters are to be found in the oldest copies and editions of the Treatise on Painting, and although the material they afford is but meager and the connection between them but slight, we must still attribute to them a special theoretical value as well as practical utility — all the more so because our knowledge of the theory and use of colours at the time of the Renaissance is still extremely limited.

The reciprocal effects of colours on objects placed opposite each other (263-272).

263.

OF PAINTING.

The hue of an illuminated object is affected by that of the luminous body.

264.

OF SHADOW.

The surface of any opaque body is affected by the colour of surrounding objects.

265.

A shadow is always affected by the colour of the surface on which it is cast.

266.

An image produced in a mirror is affected by the colour of the mirror.

267.

OF LIGHT AND SHADE.

Every portion of the surface of a body is varied [in hue] by the [reflected] colour of the object that may be opposite to it.

EXAMPLE.

If you place a spherical body between various objects that is to say with [direct] sunlight on one side of it, and on the other a wall illuminated by the sun, which wall may be green or of any other colour, while the surface on which it is placed may be red, and the two lateral sides are in shadow, you will see that the natural colour of that body will assume something of the hue reflected from those objects. The strongest will be [given by] the luminous body; the second by the illuminated wall, the third by the shadows. There will still be a portion which will take a tint from the colour of the edges.

268.

The surface of every opaque body is affected by the colour of the objects surrounding it. But this effect will be strong or weak in proportion as those objects are more or less remote and more or less strongly [coloured].

269.

OF PAINTING.

The surface of every opaque body assumes the hues reflected from surrounding objects.

The surface of an opaque body assumes the hues of surrounding objects more strongly in proportion as the rays that form the images of those objects strike the surface at more equal angles.

And the surface of an opaque body assumes a stronger hue from the surrounding objects in proportion as that surface is whiter and the colour of the object brighter or more highly illuminated.

270.

OF THE RAYS WHICH CONVEY THROUGH THE AIR THE IMAGES OF OBJECTS.

All the minutest parts of the image intersect each other without interfering with each other. To prove this let r be one of the sides of the hole, opposite to which let s be the eye which sees the lower end o of the line no . The other extremity cannot transmit its image to the eye s as it has to strike the end r and it is the same with regard to m at the middle of the line. The case is the same with the upper extremity n and the eye u . And if the end n is red the eye u on that side of the holes will not see the green colour of o , but only the red of n according to the 7th of this where it is said: Every form projects images from itself by the shortest line, which necessarily is a straight line, &c.

[Footnote: 13. This probably refers to the diagram given under No. 66.]

271.

OF PAINTING.

The surface of a body assumes in some degree the hue of those around it. The colours of illuminated objects are reflected from the surfaces of one to the other in various spots, according to the various positions of those objects. Let *o* be a blue object in full light, facing all by itself the space *b c* on the white sphere *a b e d e f*, and it will give it a blue tinge, *m* is a yellow body reflected onto the space *a b* at the same time as *o* the blue body, and they give it a green colour (by the 2nd [proposition] of this which shows that blue and yellow make a beautiful green &c.) And the rest will be set forth in the Book on Painting. In that Book it will be shown, that, by transmitting the images of objects and the colours of bodies illuminated by sunlight through a small round perforation and into a dark chamber onto a plane surface, which itself is quite white, &c.

But every thing will be upside down.

Combination of different colours in cast shadows.

272.

That which casts the shadow does not face it, because the shadows are produced by the light which causes and surrounds the shadows. The shadow caused by the light *e*, which is yellow, has a blue tinge, because the shadow of the body *a* is cast upon the pavement at *b*, where the blue light falls; and the shadow produced by the light *d*, which is blue, will be yellow at *c*, because the yellow light falls there and the surrounding background to these shadows *b c* will, besides its natural colour, assume a hue compounded of yellow and blue, because it is lighted by the yellow light and by the blue light both at once.

Shadows of various colours, as affected by the lights falling on them. That light which causes the shadow does not face it.

[Footnote: In the original diagram we find in the circle *e* “*giallo*” (yellow) and the circle *d* “*azurro*” (blue) and also under the circle of shadow to the left “*giallo*” is written and under that to the right “*azurro*”.

In the second diagram where four circles are placed in a row we find written, beginning at the left hand, “*giallo*” (yellow), “*azurro*” (blue), “*verde*” (green), “*rosso*” (red).]

The effect of colours in the camera obscura (273-274).

273.

The edges of a colour(ed object) transmitted through a small hole are more

conspicuous than the central portions.

The edges of the images, of whatever colour, which are transmitted through a small aperture into a dark chamber will always be stronger than the middle portions.

274.

OF THE INTERSECTIONS OF THE IMAGES IN THE PUPIL OF THE EYE.

The intersections of the images as they enter the pupil do not mingle in confusion in the space where that intersection unites them; as is evident, since, if the rays of the sun pass through two panes of glass in close contact, of which one is blue and the other yellow, the rays, in penetrating them, do not become blue or yellow but a beautiful green. And the same thing would happen in the eye, if the images which were yellow or green should mingle where they [meet and] intersect as they enter the pupil. As this does not happen such a mingling does not exist.

OF THE NATURE OF THE RAYS COMPOSED OF THE IMAGES OF OBJECTS, AND OF THEIR INTERSECTIONS.

The directness of the rays which transmit the forms and colours of the bodies whence they proceed does not tinge the air nor can they affect each other by contact where they intersect. They affect only the spot where they vanish and cease to exist, because that spot faces and is faced by the original source of these rays, and no other object, which surrounds that original source can be seen by the eye where these rays are cut off and destroyed, leaving there the spoil they have conveyed to it. And this is proved by the 4th [proposition], on the colour of bodies, which says: The surface of every opaque body is affected by the colour of surrounding objects; hence we may conclude that the spot which, by means of the rays which convey the image, faces — and is faced by the cause of the

image, assumes the colour of that object.

On the colours of derived shadows (275. 276).

275.

**ANY SHADOW CAST BY AN OPAQUE BODY
SMALLER THAN THE LIGHT CAUSING THE
SHADOW WILL THROW A DERIVED SHADOW
WHICH IS TINGED BY THE COLOUR OF THE
LIGHT.**

Let n be the source of the shadow $e f$; it will assume its hue. Let o be the source of $h e$ which will in the same way be tinged by its hue and so also the colour of $v h$ will be affected by p which causes it; and the shadow of the triangle $z k y$ will be affected by the colour of q , because it is produced by it. In proportion as $c d$ goes into $a d$, will $n r s$ be darker than m ; and the rest of the space will be shadowless. $f g$ is the highest light, because here the whole light of the window $a d$ falls; and thus on the opaque body $m e$ is in equally high light; $z k y$ is a triangle which includes the deepest shadow, because the light $a d$ cannot reach any part of it. $x h$ is the 2nd grade of shadow, because it receives only $1/3$ of the light from the window, that is $c d$. The third grade of shadow is $h e$, where two thirds of the light from the window is visible. The last grade of shadow is $b d e f$, because the highest grade of light from the window falls at f .

[Footnote: The diagram Pl. III, No. 1 belongs to this chapter as well as the text given in No. 148. Lines 7-11 (compare lines 8-12 of No. 148) which are written within the diagram, evidently apply to both sections and have therefore been inserted in both.]

276.

OF THE COLOURS OF SIMPLE DERIVED SHADOWS.

The colour of derived shadows is always affected by that of the body towards which they are cast. To prove this: let an opaque body be placed between the plane *s c t d* and the blue light *d e* and the red light *a b*, then I say that *d e*, the blue light, will fall on the whole surface *s c t d* excepting at *o p* which is covered by the shadow of the body *q r*, as is shown by the straight lines *d q o e r p*. And the same occurs with the light *a b* which falls on the whole surface *s c t d* excepting at the spot obscured by the shadow *q r*; as is shown by the lines *d q o*, and *e r p*. Hence we may conclude that the shadow *n m* is exposed to the blue light *d e*; but, as the red light *a b* cannot fall there, *n m* will appear as a blue shadow on a red background tinted with blue, because on the surface *s c t d* both lights can fall. But in the shadows only one single light falls; for this reason these shadows are of medium depth, since, if no light whatever mingled with the shadow, it would be of the first degree of darkness &c. But in the shadow at *o p* the blue light does not fall, because the body *q r* interposes and intercepts it there. Only the red light *a b* falls there and tinges the shadow of a red hue and so a ruddy shadow appears on the background of mingled red and blue.

The shadow of *q r* at *o p* is red, being caused by the blue light *d e*; and the shadow of *q r* at *o' p'* is blue being caused by the red light *a b*. Hence we say that the blue light in this instance causes a red derived shadow from the opaque body *q' r'*, while the red light causes the same body to cast a blue derived shadow; but the primary shadow [on the dark side of the body itself] is not of either of those hues, but a mixture of red and blue.

The derived shadows will be equal in depth if they are produced by lights of equal strength and at an equal distance; this is proved. [Footnote 53: The text is unfinished in the original.]

[Footnote: In the original diagram Leonardo has written within the circle *q r* *corpo obroso* (body in shadow); at the spot marked *A*, *luminoso azzurro* (blue luminous body); at *B*, *luminoso rosso* (red luminous body). At *E* we read *ombra azzurra* (blue tinted shadow) and at *D* *ombra rossa* (red tinted shadow).]

On the nature of colours (277. 278).

277.

No white or black is transparent.

278.

OF PAINTING.

[Footnote 2: See Footnote 3] Since white is not a colour but the neutral recipient of every colour [Footnote 3: *il bianco non e colore ma e inpotentia ricettiva d'ogni colore* (white is not a colour, but the neutral recipient of every colour). LEON BATT. ALBERTI “*Della pittura*” libro I, asserts on the contrary: “*Il bianco e'l nero non sono veri colori, ma sono alteratione delli altri colori*” (ed. JANITSCHKE, p. 67; Vienna 1877).], when it is seen in the open air and high up, all its shadows are bluish; and this is caused, according to the 4th [prop.], which says: the surface of every opaque body assumes the hue of the surrounding objects. Now this white [body] being deprived of the light of the sun by the interposition of some body between the sun and itself, all that portion of it which is exposed to the sun and atmosphere assumes the colour of the sun and atmosphere; the side on which the sun does not fall remains in shadow and assumes the hue of the atmosphere. And if this white object did not reflect the green of the fields all the way to the horizon nor get the brightness of the horizon itself, it would certainly appear simply of the same hue as the atmosphere.

On gradations in the depth of colours (279. 280).

279.

Since black, when painted next to white, looks no blacker than when next to black; and white when next to black looks no whiter than white, as is seen by the images transmitted through a small hole or by the edges of any opaque screen ...

280.

OF COLOURS.

Of several colours, all equally white, that will look whitest which is against the darkest background. And black will look intensest against the whitest background.

And red will look most vivid against the yellowest background; and the same

is the case with all colours when surrounded by their strongest contrasts.
On the reflection of colours (281-283).

281.

PERSPECTIVE.

Every object devoid of colour in itself is more or less tinged by the colour [of the object] placed opposite. This may be seen by experience, inasmuch as any object which mirrors another assumes the colour of the object mirrored in it. And if the surface thus partially coloured is white the portion which has a red reflection will appear red, or any other colour, whether bright or dark.

PERSPECTIVE.

Every opaque and colourless body assumes the hue of the colour reflected on it; as happens with a white wall.

282.

PERSPECTIVE.

That side of an object in light and shade which is towards the light transmits the images of its details more distinctly and immediately to the eye than the side which is in shadow.

PERSPECTIVE.

The solar rays reflected on a square mirror will be thrown back to distant objects in a circular form.

PERSPECTIVE.

Any white and opaque surface will be partially coloured by reflections from surrounding objects.

[Footnote 281. 282: The title line of these chapters is in the original simply “*pro*”, which may be an abbreviation for either *Propositione* or *Prospettiva* — taking *Prospettiva* of course in its widest sense, as we often find it used in Leonardo’s writings. The title “*pro*” has here been understood to mean *Prospettiva*, in accordance with the suggestion afforded by page 10b of this same MS., where the first section is headed *Prospettiva* in full (see No. 94), while the four following sections are headed merely “*pro*” (see No. 85).]

283.

WHAT PORTION OF A COLOURED SURFACE OUGHT IN REASON TO BE THE MOST INTENSE.

If *a* is the light, and *b* illuminated by it in a direct line, *c*, on which the light cannot fall, is lighted only by reflection from *b* which, let us say, is red. Hence the light reflected from it, will be affected by the hue of the surface causing it and will tinge the surface *c* with red. And if *c* is also red you will see it much more intense than *b*; and if it were yellow you would see there a colour between yellow and red.

On the use of dark and light colours in painting (284 — 286).

284.

WHY BEAUTIFUL COLOURS MUST BE IN THE [HIGHEST] LIGHT.

Since we see that the quality of colour is known [only] by means of light, it is to be supposed that where there is most light the true character of a colour in light will be best seen; and where there is most shadow the colour will be affected by the tone of that. Hence, O Painter! remember to show the true quality of colours in bright lights.

285.

An object represented in white and black will display stronger relief than in any other way; hence I would remind you O Painter! to dress your figures in the lightest colours you can, since, if you put them in dark colours, they will be in too slight relief and inconspicuous from a distance. And the reason is that the shadows of all objects are dark. And if you make a dress dark there is little variety in the lights and shadows, while in light colours there are many grades.

286.

OF PAINTING.

Colours seen in shadow will display more or less of their natural brilliancy in proportion as they are in fainter or deeper shadow.

But if these same colours are situated in a well-lighted place, they will appear brighter in proportion as the light is more brilliant.

THE ADVERSARY.

The variety of colours in shadow must be as great as that of the colours in the objects in that shadow.

THE ANSWER.

Colours seen in shadow will display less variety in proportion as the shadows in which they lie are deeper. And evidence of this is to be had by looking from an

open space into the doorways of dark and shadowy churches, where the pictures which are painted in various colours all look of uniform darkness.

Hence at a considerable distance all the shadows of different colours will appear of the same darkness.

It is the light side of an object in light and shade which shows the true colour.

On the colours of the rainbow (287. 288).

287.

Treat of the rainbow in the last book on Painting, but first write the book on colours produced by the mixture of other colours, so as to be able to prove by those painters' colours how the colours of the rainbow are produced.

288.

WHETHER THE COLOURS OF THE RAINBOW ARE PRODUCED BY THE SUN.

The colours of the rainbow are not produced by the sun, for they occur in many ways without the sunshine; as may be seen by holding a glass of water up to the eye; when, in the glass — where there are those minute bubbles always seen in coarse glass — each bubble, even though the sun does not fall on it, will produce on one side all the colours of the rainbow; as you may see by placing the glass between the day light and your eye in such a way as that it is close to the eye, while on one side the glass admits the [diffused] light of the atmosphere, and on the other side the shadow of the wall on one side of the window; either left or right, it matters not which. Then, by turning the glass round you will see these colours all round the bubbles in the glass &c. And the rest shall be said in its place.

THAT THE EYE HAS NO PART IN PRODUCING THE COLOURS OF THE RAINBOW.

In the experiment just described, the eye would seem to have some share in the colours of the rainbow, since these bubbles in the glass do not display the colours except through the medium of the eye. But, if you place the glass full of water on the window sill, in such a position as that the outer side is exposed to

the sun's rays, you will see the same colours produced in the spot of light thrown through the glass and upon the floor, in a dark place, below the window; and as the eye is not here concerned in it, we may evidently, and with certainty pronounce that the eye has no share in producing them.

OF THE COLOURS IN THE FEATHERS OF CERTAIN BIRDS.

There are many birds in various regions of the world on whose feathers we see the most splendid colours produced as they move, as we see in our own country in the feathers of peacocks or on the necks of ducks or pigeons, &c.

Again, on the surface of antique glass found underground and on the roots of turnips kept for some time at the bottom of wells or other stagnant waters [we see] that each root displays colours similar to those of the real rainbow. They may also be seen when oil has been placed on the top of water and in the solar rays reflected from the surface of a diamond or beryl; again, through the angular facet of a beryl every dark object against a background of the atmosphere or any thing else equally pale-coloured is surrounded by these rainbow colours between the atmosphere and the dark body; and in many other circumstances which I will not mention, as these suffice for my purpose.

VI. PERSPECTIVE OF COLOUR AND AERIAL PERSPECTIVE.

Leonardo distinctly separates these branches of his subject, as may be seen in the beginning of No. 295. Attempts have been made to cast doubts on the results which Leonardo arrived at by experiment on the perspective of colour, but not with justice, as may be seen from the original text of section 294.

The question as to the composition of the atmosphere, which is inseparable from a discussion on Aerial Perspective, forms a separate theory which is treated at considerable length. Indeed the author enters into it so fully that we cannot escape the conviction that he must have dwelt with particular pleasure on this part of his subject, and that he attached great importance to giving it a character of general applicability.

General rules (289 — 291).

289.

The variety of colour in objects cannot be discerned at a great distance, excepting in those parts which are directly lighted up by the solar rays.

290.

As to the colours of objects: at long distances no difference is perceptible in the parts in shadow.

291.

OF THE VISIBILITY OF COLOURS.

Which colour strikes most? An object at a distance is most conspicuous, when it

is lightest, and the darkest is least visible.
An exceptional case.

292.

Of the edges [outlines] of shadows. Some have misty and ill defined edges, others distinct ones.

No opaque body can be devoid of light and shade, except it is in a mist, on ground covered with snow, or when snow is falling on the open country which has no light on it and is surrounded with darkness.

And this occurs [only] in spherical bodies, because in other bodies which have limbs and parts, those sides of limbs which face each other reflect on each other the accidental [hue and tone] of their surface.

An experiment.

293.

ALL COLOURS ARE AT A DISTANCE UNDISTINGUISHABLE AND UNDISCERNIBLE.

All colours at a distance are undistinguishable in shadow, because an object which is not in the highest light is incapable of transmitting its image to the eye through an atmosphere more luminous than itself; since the lesser brightness must be absorbed by the greater. For instance: We, in a house, can see that all the colours on the surface of the walls are clearly and instantly visible when the windows of the house are open; but if we were to go out of the house and look in at the windows from a little distance to see the paintings on those walls, instead of the paintings we should see an uniform deep and colourless shadow.

The practice of the *prospettiva de colori*.

294.

HOW A PAINTER SHOULD CARRY OUT THE

PERSPECTIVE OF COLOUR IN PRACTICE.

In order to put into practice this perspective of the variation and loss or diminution of the essential character of colours, observe at every hundred braccia some objects standing in the landscape, such as trees, houses, men and particular places. Then in front of the first tree have a very steady plate of glass and keep your eye very steady, and then, on this plate of glass, draw a tree, tracing it over the form of that tree. Then move it on one side so far as that the real tree is close by the side of the tree you have drawn; then colour your drawing in such a way as that in colour and form the two may be alike, and that both, if you close one eye, seem to be painted on the glass and at the same distance. Then, by the same method, represent a second tree, and a third, with a distance of a hundred braccia between each. And these will serve as a standard and guide whenever you work on your own pictures, wherever they may apply, and will enable you to give due distance in those works. But I have found that as a rule the second is $\frac{4}{5}$ of the first when it is 20 braccia beyond it.

[Footnote: This chapter is one of those copied in the Manuscript of the Vatican library Urbinas 1270, and the original text is rendered here with no other alterations, but in the orthography. H. LUDWIG, in his edition of this copy translates lines 14 and 15 thus: "*Ich finde aber als Regel, dass der zweite um vier Funftel des ersten abnimmt, wenn er namlich zwanzig Ellen vom ersten entfernt ist (?)*". He adds in his commentary: "*Das Ende der Nummer ist wohl jedenfalls verstummelt*". However the translation given above shows that it admits of a different rendering.]

The rules of aerial perspective (295 — 297).

295.

OF AERIAL PERSPECTIVE.

There is another kind of perspective which I call Aerial Perspective, because by the atmosphere we are able to distinguish the variations in distance of different buildings, which appear placed on a single line; as, for instance, when we see several buildings beyond a wall, all of which, as they appear above the top of the

wall, look of the same size, while you wish to represent them in a picture as more remote one than another and to give the effect of a somewhat dense atmosphere. You know that in an atmosphere of equal density the remotest objects seen through it, as mountains, in consequence of the great quantity of atmosphere between your eye and them — appear blue and almost of the same hue as the atmosphere itself [Footnote 10: *quando il sole e per leuante* (when the sun is in the East). Apparently the author refers here to morning light in general. H. LUDWIG however translates this passage from the Vatican copy “*wenn namlich die Sonne (dahinter) im Osten steht*”.] when the sun is in the East [Footnote 11: See Footnote 10]. Hence you must make the nearest building above the wall of its real colour, but the more distant ones make less defined and bluer. Those you wish should look farthest away you must make proportionately bluer; thus, if one is to be five times as distant, make it five times bluer. And by this rule the buildings which above a [given] line appear of the same size, will plainly be distinguished as to which are the more remote and which larger than the others.

296.

The medium lying between the eye and the object seen, tinges that object with its colour, as the blueness of the atmosphere makes the distant mountains appear blue and red glass makes objects seen beyond it, look red. The light shed round them by the stars is obscured by the darkness of the night which lies between the eye and the radiant light of the stars.

297.

Take care that the perspective of colour does not disagree with the size of your objects, that is to say: that the colours diminish from their natural [vividness] in proportion as the objects at various distances diminish from their natural size.

On the relative density of the atmosphere (298 — 290).

298.

WHY THE ATMOSPHERE MUST BE

REPRESENTED AS PALER TOWARDS THE LOWER PORTION.

Because the atmosphere is dense near the earth, and the higher it is the rarer it becomes. When the sun is in the East if you look towards the West and a little way to the South and North, you will see that this dense atmosphere receives more light from the sun than the rarer; because the rays meet with greater resistance. And if the sky, as you see it, ends on a low plain, that lowest portion of the sky will be seen through a denser and whiter atmosphere, which will weaken its true colour as seen through that medium, and there the sky will look whiter than it is above you, where the line of sight travels through a smaller space of air charged with heavy vapour. And if you turn to the East, the atmosphere will appear darker as you look lower down because the luminous rays pass less freely through the lower atmosphere.

299.

OF THE MODE OF TREATING REMOTE OBJECTS IN PAINTING.

It is easy to perceive that the atmosphere which lies closest to the level ground is denser than the rest, and that where it is higher up, it is rarer and more transparent. The lower portions of large and lofty objects which are at a distance are not much seen, because you see them along a line which passes through a denser and thicker section of the atmosphere. The summits of such heights are seen along a line which, though it starts from your eye in a dense atmosphere, still, as it ends at the top of those lofty objects, ceases in a much rarer atmosphere than exists at their base; for this reason the farther this line extends from your eye, from point to point the atmosphere becomes more and more rare. Hence, O Painter! when you represent mountains, see that from hill to hill the bases are paler than the summits, and in proportion as they recede beyond each other make the bases paler than the summits; while, the higher they are the more you must show of their true form and colour.

On the colour of the atmosphere (300-307).

OF THE COLOUR OF THE ATMOSPHERE.

I say that the blueness we see in the atmosphere is not intrinsic colour, but is caused by warm vapour evaporated in minute and insensible atoms on which the solar rays fall, rendering them luminous against the infinite darkness of the fiery sphere which lies beyond and includes it. And this may be seen, as I saw it by any one going up [Footnote 5: With regard to the place spoken of as *M'oboso* (compare No. 301 line 20) its identity will be discussed under Leonardo's Topographical notes in Vol. II.] Monboso, a peak of the Alps which divide France from Italy. The base of this mountain gives birth to the four rivers which flow in four different directions through the whole of Europe. And no mountain has its base at so great a height as this, which lifts itself almost above the clouds; and snow seldom falls there, but only hail in the summer, when the clouds are highest. And this hail lies [unmelted] there, so that if it were not for the absorption of the rising and falling clouds, which does not happen twice in an age, an enormous mass of ice would be piled up there by the hail, and in the middle of July I found it very considerable. There I saw above me the dark sky, and the sun as it fell on the mountain was far brighter here than in the plains below, because a smaller extent of atmosphere lay between the summit of the mountain and the sun. Again as an illustration of the colour of the atmosphere I will mention the smoke of old and dry wood, which, as it comes out of a chimney, appears to turn very blue, when seen between the eye and the dark distance. But as it rises, and comes between the eye and the bright atmosphere, it at once shows of an ashy grey colour; and this happens because it no longer has darkness beyond it, but this bright and luminous space. If the smoke is from young, green wood, it will not appear blue, because, not being transparent and being full of superabundant moisture, it has the effect of condensed clouds which take distinct lights and shadows like a solid body. The same occurs with the atmosphere, which, when overcharged with moisture appears white, and the small amount of heated moisture makes it dark, of a dark blue colour; and this will suffice us so far as concerns the colour of the atmosphere; though it might be added that, if this transparent blue were the natural colour of the atmosphere, it would follow that wherever a larger mass air intervened between the eye and the element of fire, the azure colour would be more intense; as we see in blue

glass and in sapphires, which are darker in proportion as they are larger. But the atmosphere in such circumstances behaves in an opposite manner, inasmuch as where a greater quantity of it lies between the eye and the sphere of fire, it is seen much whiter. This occurs towards the horizon. And the less the extent of atmosphere between the eye and the sphere of fire, the deeper is the blue colour, as may be seen even on low plains. Hence it follows, as I say, that the atmosphere assumes this azure hue by reason of the particles of moisture which catch the rays of the sun. Again, we may note the difference in particles of dust, or particles of smoke, in the sun beams admitted through holes into a dark chamber, when the former will look ash grey and the thin smoke will appear of a most beautiful blue; and it may be seen again in the dark shadows of distant mountains when the air between the eye and those shadows will look very blue, though the brightest parts of those mountains will not differ much from their true colour. But if any one wishes for a final proof let him paint a board with various colours, among them an intense black; and over all let him lay a very thin and transparent [coating of] white. He will then see that this transparent white will nowhere show a more beautiful blue than over the black — but it must be very thin and finely ground.

[Footnote 7: *reta* here has the sense of *malanno*.]

301.

Experience shows us that the air must have darkness beyond it and yet it appears blue. If you produce a small quantity of smoke from dry wood and the rays of the sun fall on this smoke, and if you then place behind the smoke a piece of black velvet on which the sun does not shine, you will see that all the smoke which is between the eye and the black stuff will appear of a beautiful blue colour. And if instead of the velvet you place a white cloth smoke, that is too thick smoke, hinders, and too thin smoke does not produce, the perfection of this blue colour. Hence a moderate amount of smoke produces the finest blue. Water violently ejected in a fine spray and in a dark chamber where the sun beams are admitted produces these blue rays and the more vividly if it is distilled water, and thin smoke looks blue. This I mention in order to show that the blueness of the atmosphere is caused by the darkness beyond it, and these instances are given for those who cannot confirm my experience on Monboso.

302.

When the smoke from dry wood is seen between the eye of the spectator and some dark space [or object], it will look blue. Thus the sky looks blue by reason of the darkness beyond it. And if you look towards the horizon of the sky, you will see the atmosphere is not blue, and this is caused by its density. And thus at each degree, as you raise your eyes above the horizon up to the sky over your head, you will see the atmosphere look darker [blue] and this is because a smaller density of air lies between your eye and the [outer] darkness. And if you go to the top of a high mountain the sky will look proportionately darker above you as the atmosphere becomes rarer between you and the [outer] darkness; and this will be more visible at each degree of increasing height till at last we should find darkness.

That smoke will look bluest which rises from the driest wood and which is nearest to the fire and is seen against the darkest background, and with the sunlight upon it.

303.

A dark object will appear bluest in proportion as it has a greater mass of luminous atmosphere between it and the eye. As may be seen in the colour of the sky.

304.

The atmosphere is blue by reason of the darkness above it because black and white make blue.

305.

In the morning the mist is denser above than below, because the sun draws it upwards; hence tall buildings, even if the summit is at the same distance as the base have the summit invisible. Therefore, also, the sky looks darkest [in colour] overhead, and towards the horizon it is not blue but rather between smoke and dust colour.

The atmosphere, when full of mist, is quite devoid of blueness, and only appears of the colour of clouds, which shine white when the weather is fine. And the more you turn to the west the darker it will be, and the brighter as you look

to the east. And the verdure of the fields is bluish in a thin mist, but grows grey in a dense one.

The buildings in the west will only show their illuminated side, where the sun shines, and the mist hides the rest. When the sun rises and chases away the haze, the hills on the side where it lifts begin to grow clearer, and look blue, and seem to smoke with the vanishing mists; and the buildings reveal their lights and shadows; through the thinner vapour they show only their lights and through the thicker air nothing at all. This is when the movement of the mist makes it part horizontally, and then the edges of the mist will be indistinct against the blue of the sky, and towards the earth it will look almost like dust blown up. In proportion as the atmosphere is dense the buildings of a city and the trees in a landscape will look fewer, because only the tallest and largest will be seen.

Darkness affects every thing with its hue, and the more an object differs from darkness, the more we see its real and natural colour. The mountains will look few, because only those will be seen which are farthest apart; since, at such a distance, the density increases to such a degree that it causes a brightness by which the darkness of the hills becomes divided and vanishes indeed towards the top. There is less [mist] between lower and nearer hills and yet little is to be distinguished, and least towards the bottom.

306.

The surface of an object partakes of the colour of the light which illuminates it; and of the colour of the atmosphere which lies between the eye and that object, that is of the colour of the transparent medium lying between the object and the eye; and among colours of a similar character the second will be of the same tone as the first, and this is caused by the increased thickness of the colour of the medium lying between the object and the eye.

307. OF PAINTING.

Of various colours which are none of them blue that which at a great distance will look bluest is the nearest to black; and so, conversely, the colour which is least like black will at a great distance best preserve its own colour.

Hence the green of fields will assume a bluer hue than yellow or white will, and conversely yellow or white will change less than green, and red still less.

VII. ON THE PROPORTIONS AND ON THE MOVEMENTS OF THE HUMAN FIGURE.

Leonardo's researches on the proportions and movements of the human figure must have been for the most part completed and written before the year 1498; for LUCA PACIOLO writes, in the dedication to Ludovico il Moro, of his book Divina Proportione, which was published in that year: "Leonardo da Vinci ... ha uedo gia co tutta diligitia al degno libro de pictura e movimenti humani posto fine".

The selection of Leonardo's axioms contained in the Vatican copy attributes these words to the author: "e il resto si dira nella universale misura del huomo". (MANZI, p. 147; LUDWIG, No. 264). LOMAZZO, again, in his Idea del Tempio della Pittura Milano 1590, cap. IV, says: "Lionardo Vinci ... dimostro anco in figura tutte le proporzioni dei membri del corpo umano".

The Vatican copy includes but very few sections of the "Universale misura del huomo" and until now nothing has been made known of the original MSS. on the subject which have supplied the very extensive materials for this portion of the work. The collection at Windsor, belonging to her Majesty the Queen, includes by far the most important part of Leonardo's investigations on this subject, constituting about half of the whole of the materials here published; and the large number of original drawings adds greatly to the interest which the subject itself must command. Luca Paciolo would seem to have had these MSS. (which I have distinguished by the initials W. P.) in his mind when he wrote the passage quoted above. Still, certain notes of a later date — such as Nos. 360, 362 and 363, from MS. E, written in 1513 — 14, sufficiently prove that Leonardo did not consider his earlier studies on the Proportions and Movements of the Human Figure final and complete, as we might suppose from Luca Paciolo's statement. Or else he took the subject up again at a subsequent period, since his former researches had been carried on at Milan between 1490 and 1500. Indeed it is highly probable that the anatomical studies which he was pursuing with so much zeal between 1510 — 16 should have led him to reconsider the subject of Proportion.

Preliminary observations (308. 309).

308.

Every man, at three years old is half the full height he will grow to at last.

309.

If a man 2 braccia high is too small, one of four is too tall, the medium being what is admirable. Between 2 and 4 comes 3; therefore take a man of 3 braccia in height and measure him by the rule I will give you. If you tell me that I may be mistaken, and judge a man to be well proportioned who does not conform to this division, I answer that you must look at many men of 3 braccia, and out of the larger number who are alike in their limbs choose one of those who are most graceful and take your measurements. The length of the hand is $\frac{1}{3}$ of a braccio [8 inches] and this is found 9 times in man. And the face [Footnote 7: The account here given of the *braccio* is of importance in understanding some of the succeeding chapters. *Testa* must here be understood to mean the face. The statements in this section are illustrated in part on Pl. XI.] is the same, and from the pit of the throat to the shoulder, and from the shoulder to the nipple, and from one nipple to the other, and from each nipple to the pit of the throat.

Proportions of the head and face (310-318).

310.

The space between the parting of the lips [the mouth] and the base of the nose is one-seventh of the face.

The space from the mouth to the bottom of the chin *c d* is the fourth part of the face and equal to the width of the mouth.

The space from the chin to the base of the nose *e f* is the third part of the face and equal to the length of the nose and to the forehead.

The distance from the middle of the nose to the bottom of the chin *g h*, is half the length of the face.

The distance from the top of the nose, where the eyebrows begin, to the bottom of the chin, *i k*, is two thirds of the face.

The space from the parting of the lips to the top of the chin *l m*, that is where the chin ends and passes into the lower lip of the mouth, is the third of the distance from the parting of the lips to the bottom of the chin and is the twelfth

part of the face. From the top to the bottom of the chin $m n$ is the sixth part of the face and is the fifty fourth part of a man's height.

From the farthest projection of the chin to the throat $o p$ is equal to the space between the mouth and the bottom of the chin, and a fourth of the face.

The distance from the top of the throat to the pit of the throat below $q r$ is half the length of the face and the eighteenth part of a man's height.

From the chin to the back of the neck $s t$, is the same distance as between the mouth and the roots of the hair, that is three quarters of the head.

From the chin to the jaw bone $v x$ is half the head and equal to the thickness of the neck in profile.

The thickness of the head from the brow to the nape is once and $\frac{3}{4}$ that of the neck.

[Footnote: The drawings to this text, lines 1-10 are on Pl. VII, No. I. The two upper sketches of heads, Pl. VII, No. 2, belong to lines 11-14, and in the original are placed immediately below the sketches reproduced on Pl. VII, No. 1.]

311.

The distance from the attachment of one ear to the other is equal to that from the meeting of the eyebrows to the chin, and in a fine face the width of the mouth is equal to the length from the parting of the lips to the bottom of the chin.

312.

The cut or depression below the lower lip of the mouth is half way between the bottom of the nose and the bottom of the chin.

The face forms a square in itself; that is its width is from the outer corner of one eye to the other, and its height is from the very top of the nose to the bottom of the lower lip of the mouth; then what remains above and below this square amounts to the height of such another square, $a b$ is equal to the space between $c d$; $d n$ in the same way to $n c$, and likewise $s r$, $q p$, $h k$ are equal to each other.

It is as far between m and s as from the bottom of the nose to the chin. The ear is exactly as long as the nose. It is as far from x to j as from the nose to the chin. The parting of the mouth seen in profile slopes to the angle of the jaw. The ear should be as high as from the bottom of the nose to the top of the eye-lid. The space between the eyes is equal to the width of an eye. The ear is over the middle of the neck, when seen in profile. The distance from 4 to 5 is equal to

that from s to r .

[Footnote: See Pl. VIII, No. I, where the text of lines 3-13 is also given in facsimile.]

313.

($a\ b$) is equal to ($c\ d$).

[Footnote: See Pl. VII, No. 3. Reference may also be made here to two pen and ink drawings of heads in profile with figured measurements, of which there is no description in the MS. These are given on Pl. XVII, No. 2. — A head, to the left, with part of the torso [W. P. 5a], No. 1 on the same plate is from MS. A 2b and in the original occurs on a page with wholly irrelevant text on matters of natural history. M. RAVAISSON in his edition of the Paris MS. A has reproduced this head and discussed it fully [note on page 12]; he has however somewhat altered the original measurements. The complicated calculations which M. RAVAISSON has given appear to me in no way justified. The sketch, as we see it, can hardly have been intended for any thing more than an experimental attempt to ascertain relative proportions. We do not find that Leonardo made use of circular lines in any other study of the proportions of the human head. At the same time we see that the proportions of this sketch are not in accordance with the rules which he usually observed (see for instance No. 310).]

The head $a\ f\ 1/6$ larger than $n\ f$.

315.

From the eyebrow to the junction of the lip with the chin, and the angle of the jaw and the upper angle where the ear joins the temple will be a perfect square. And each side by itself is half the head.

The hollow of the cheek bone occurs half way between the tip of the nose and the top of the jaw bone, which is the lower angle of the setting on of the ear, in the frame here represented.

From the angle of the eye-socket to the ear is as far as the length of the ear, or the third of the face.

[Footnote: See Pl. IX. The text, in the original is written behind the head. The handwriting would seem to indicate a date earlier than 1480. On the same leaf there is a drawing in red chalk of two horsemen of which only a portion of the

upper figure is here visible. The whole leaf measures 22 1/2 centimetres wide by 29 long, and is numbered 127 in the top right-hand corner.]

316.

From *a* to *b* — that is to say from the roots of the hair in front to the top of the head — ought to be equal to *c d*; — that is from the bottom of the nose to the meeting of the lips in the middle of the mouth. From the inner corner of the eye *m* to the top of the head *a* is as far as from *m* down to the chin *s*. *s c f b* are all at equal distances from each other.

[Footnote: The drawing in silver-point on bluish tinted paper — Pl. X — which belongs to this chapter has been partly drawn over in ink by Leonardo himself.]

317.

From the top of the head to the bottom of the chin is 1/9, and from the roots of the hair to the chin is 1/9 of the distance from the roots of the hair to the ground. The greatest width of the face is equal to the space between the mouth and the roots of the hair and is 1/12 of the whole height. From the top of the ear to the top of the head is equal to the distance from the bottom of the chin to the lachrymatory duct of the eye; and also equal to the distance from the angle of the chin to that of the jaw; that is the 1/16 of the whole. The small cartilage which projects over the opening of the ear towards the nose is half-way between the nape and the eyebrow; the thickness of the neck in profile is equal to the space between the chin and the eyes, and to the space between the chin and the jaw, and it is 1/18 of the height of the man.

318.

a b, c d, e f, g h, i k are equal to each other in size excepting that *d f* is accidental.

[Footnote: See Pl. XI.]

Proportions of the head seen in front (319-321).

319.

a n o f are equal to the mouth.

a c and *a f* are equal to the space between one eye and the other.

n m o f q r are equal to half the width of the eye lids, that is from the inner [lachrymatory] corner of the eye to its outer corner; and in like manner the division between the chin and the mouth; and in the same way the narrowest part of the nose between the eyes. And these spaces, each in itself, is the 19th part of the head, *n o* is equal to the length of the eye or of the space between the eyes.

m c is $\frac{1}{3}$ of *n m* measuring from the outer corner of the eyelids to the letter *c*.
b s will be equal to the width of the nostril.

[Footnote: See Pl. XII.]

320.

The distance between the centres of the pupils of the eyes is $\frac{1}{3}$ of the face. The space between the outer corners of the eyes, that is where the eye ends in the eye socket which contains it, thus the outer corners, is half the face.

The greatest width of the face at the line of the eyes is equal to the distance from the roots of the hair in front to the parting of the lips.

[Footnote: There are, with this section, two sketches of eyes, not reproduced here.]

321.

The nose will make a double square; that is the width of the nose at the nostrils goes twice into the length from the tip of the nose to the eyebrows. And, in the same way, in profile the distance from the extreme side of the nostril where it joins the cheek to the tip of the nose is equal to the width of the nose in front from one nostril to the other. If you divide the whole length of the nose — that is from the tip to the insertion of the eyebrows, into 4 equal parts, you will find that one of these parts extends from the tip of the nostrils to the base of the nose, and the upper division lies between the inner corner of the eye and the insertion of the eyebrows; and the two middle parts [together] are equal to the length of the eye from the inner to the outer corner.

[Footnote: The two bottom sketches on Pl. VII, No. 4 face the six lines of this section, — With regard to the proportions of the head in profile see No. 312.]

322.

The great toe is the sixth part of the foot, taking the measure in profile, on the inside of the foot, from where this toe springs from the ball of the sole of the foot to its tip *a b*; and it is equal to the distance from the mouth to the bottom of the chin. If you draw the foot in profile from the outside, make the little toe begin at three quarters of the length of the foot, and you will find the same distance from the insertion of this toe as to the farthest prominence of the great toe.

323.

For each man respectively the distance between *a b* is equal to *c d*.

324.

Relative proportion of the hand and foot.

The foot is as much longer than the hand as the thickness of the arm at the wrist where it is thinnest seen facing.

Again, you will find that the foot is as much longer than the hand as the space between the inner angle of the little toe to the last projection of the big toe, if you measure along the length of the foot.

The palm of the hand without the fingers goes twice into the length of the foot without the toes.

If you hold your hand with the fingers straight out and close together you will find it to be of the same width as the widest part of the foot, that is where it is joined onto the toes.

And if you measure from the prominence of the inner angle to the end of the great toe you will find this measure to be as long as the whole hand.

From the top angle of the foot to the insertion of the toes is equal to the hand from wrist joint to the tip of the thumb.

The smallest width of the hand is equal to the smallest width of the foot between its joint into the leg and the insertion of the toes.

The width of the heel at the lower part is equal to that of the arm where it joins the hand; and also to the leg where it is thinnest when viewed in front.

The length of the longest toe, from its first division from the great toe to its tip is the fourth of the foot from the centre of the ankle bone to the tip, and it is

equal to the width of the mouth. The distance between the mouth and the chin is equal to that of the knuckles and of the three middle fingers and to the length of their first joints if the hand is spread, and equal to the distance from the joint of the thumb to the outset of the nails, that is the fourth part of the hand and of the face.

The space between the extreme poles inside and outside the foot called the ancle or ancle bone *a b* is equal to the space between the mouth and the inner corner of the eye.

325.

The foot, from where it is attached to the leg, to the tip of the great toe is as long as the space between the upper part of the chin and the roots of the hair *a b*; and equal to five sixths of the face.

326.

a d is a head's length, *c b* is a head's length. The four smaller toes are all equally thick from the nail at the top to the bottom, and are 1/13 of the foot.

[Footnote: See Pl. XIV, No. 1, a drawing of a foot with the text in three lines below it.]

327.

The whole length of the foot will lie between the elbow and the wrist and between the elbow and the inner angle of the arm towards the breast when the arm is folded. The foot is as long as the whole head of a man, that is from under the chin to the topmost part of the head[Footnote 2: *nel modo che qui i figurato*. See Pl. VII, No. 4, the upper figure. The text breaks off at the end of line 2 and the text given under No. 321 follows below. It may be here remarked that the second sketch on W. P. 311 has in the original no explanatory text.] in the way here figured.

Proportions of the leg (328-331).

328.

The greatest thickness of the calf of the leg is at a third of its height *a b*, and is a twentieth part thicker than the greatest thickness of the foot.

a c is half of the head, and equal to *d b* and to the insertion of the five toes *e f*. *d k* diminishes one sixth in the leg *g h*. *g h* is $\frac{1}{3}$ of the head; *m n* increases one sixth from *a e* and is $\frac{7}{12}$ of the head, *o p* is $\frac{1}{10}$ less than *d k* and is $\frac{6}{17}$ of the head. *a* is at half the distance between *b q*, and is $\frac{1}{4}$ of the man. *r* is half way between *s* and *b*[Footnote 11: *b* is here and later on measured on the right side of the foot as seen by the spectator.]. The concavity of the knee outside *r* is higher than that inside *a*. The half of the whole height of the leg from the foot *r*, is half way between the prominence *s* and the ground *b*. *v* is half way between *t* and *b*. The thickness of the thigh seen in front is equal to the greatest width of the face, that is $\frac{2}{3}$ of the length from the chin to the top of the head; *z r* is $\frac{5}{6}$ of 7 to *v*; *m n* is equal to 7 *v* and is $\frac{1}{4}$ of *r b*, *x y* goes 3 times into *r b*, and into *r s*.

[Footnote 22-35: The sketch illustrating these lines is on Pl. XIII, No. 2.]

[Footnote 22: *a b entra in c f 6 e 6 in c n*. Accurate measurement however obliges us to read 7 for 6.] *a b* goes six times into *c f* and six times into *c n* and is equal to *g h*; *i k l m* goes 4 times into *d f*, and 4 times into *d n* and is $\frac{3}{7}$ of the foot; *p q r s* goes 3 times into *d f*, and 3 times into *b n*; [Footnote: 25. *y* is not to be found on the diagram and *x* occurs twice; this makes the passage very obscure.] *x y* is $\frac{1}{8}$ of *x f* and is equal to *n q*. 3 7 is $\frac{1}{9}$ of *n f*; 4 5 is $\frac{1}{10}$ of *n f* [Footnote: 22-27. Compare with this lines 18-24 of No. 331, and the sketch of a leg in profile Pl. XV.].

I want to know how much a man increases in height by standing on tip-toe and how much *p g* diminishes by stooping; and how much it increases at *n q* likewise in bending the foot.

[Footnote 34: *e f 4 dal cazo*. By reading *i* for *e* the sense of this passage is made clear.] *e f* is four times in the distance between the genitals and the sole of the foot; [Footnote 35: 2 is not to be found in the sketch which renders the passage obscure. The two last lines are plainly legible in the facsimile.] 3 7 is six times from 3 to 2 and is equal to *g h* and *i k*.

[Footnote: The drawing of a leg seen in front Pl. XIII, No. 1 belongs to the text from lines 3-21. The measurements in this section should be compared with the text No. 331, lines 1-13, and the sketch of a leg seen in front on Pl. XV.]

The length of the foot from the end of the toes to the heel goes twice into that from the heel to the knee, that is where the leg bone [fibula] joins the thigh bone [femur].

330.

a n b are equal; *c n d* are equal; *n c* makes two feet; *n d* makes 2 feet.

[Footnote: See the lower sketch, Pl. XIV, No. 1.]

331.

m n o are equal. The narrowest width of the leg seen in front goes 8 times from the sole of the foot to the joint of the knee, and is the same width as the arm, seen in front at the wrist, and as the longest measure of the ear, and as the three chief divisions into which we divide the face; and this measurement goes 4 times from the wrist joint of the hand to the point of the elbow. The foot is as long as the space from the knee between *a* and *b*; and the patella of the knee is as long as the leg between *r* and *s*.

The least thickness of the leg in profile goes 6 times from the sole of the foot to the knee joint and is the same width as the space between the outer corner of the eye and the opening of the ear, and as the thickest part of the arm seen in profile and between the inner corner of the eye and the insertion of the hair.

a b c [d] are all relatively of equal length, *c d* goes twice from the sole of the foot to the centre of the knee and the same from the knee to the hip.

a b c are equal; *a* to *b* is 2 feet — that is to say measuring from the heel to the tip of the great toe.

[Footnote: See Pl. XV. The text of lines 2-17 is to the left of the front view of the leg, to which it refers. Lines 18-27 are in the middle column and refer to the leg seen in profile and turned to the left, on the right hand side of the writing. Lines 20-30 are above, to the left and apply to the sketch below them.

Some farther remarks on the proportion of the leg will be found in No. 336, lines 6, 7.]

On the central point of the whole body.

332.

In kneeling down a man will lose the fourth part of his height.

When a man kneels down with his hands folded on his breast the navel will mark half his height and likewise the points of the elbows.

Half the height of a man who sits — that is from the seat to the top of the head — will be where the arms fold below the breast, and below the shoulders. The seated portion — that is from the seat to the top of the head — will be more than half the man's [whole height] by the length of the scrotum.

[Footnote: See Pl. VIII, No. 2.]

The relative proportions of the torso and of the whole figure.

333.

The cubit is one fourth of the height of a man and is equal to the greatest width of the shoulders. From the joint of one shoulder to the other is two faces and is equal to the distance from the top of the breast to the navel. [Footnote 9: *dalla detta somita*. It would seem more accurate to read here *dal detto ombilico*.] From this point to the genitals is a face's length.

[Footnote: Compare with this the sketches on the other page of the same leaf. Pl. VIII, No. 2.]

The relative proportions of the head and of the torso.

334.

From the roots of the hair to the top of the breast *a b* is the sixth part of the height of a man and this measure is equal.

From the outside part of one shoulder to the other is the same distance as from the top of the breast to the navel and this measure goes four times from the sole of the foot to the lower end of the nose.

The [thickness of] the arm where it springs from the shoulder in front goes 6 times into the space between the two outside edges of the shoulders and 3 times into the face, and four times into the length of the foot and three into the hand, inside or outside.

[Footnote: The three sketches Pl. XIV, No. 2 belong to this text.]

The relative proportions of the torso and of the leg (335. 336).

335.

a b c are equal to each other and to the space from the armpit of the shoulder to the genitals and to the distance from the tip of the fingers of the hand to the joint of the arm, and to the half of the breast; and you must know that *c b* is the third part of the height of a man from the shoulders to the ground; *d e f* are equal to each other and equal to the greatest width of the shoulders.

[Footnote: See Pl. XVI, No. 1.]

336.

— Top of the chin — hip — the insertion of the middle finger. The end of the calf of the leg on the inside of the thigh. — The end of the swelling of the shin bone of the leg. The smallest thickness of the leg goes 3 times into the thigh seen in front.

[Footnote: See Pl. XVII, No. 2, middle sketch.]

The relative proportions of the torso and of the foot.

337.

The torso *a b* in its thinnest part measures a foot; and from *a* to *b* is 2 feet, which makes two squares to the seat — its thinnest part goes 3 times into the length, thus making 3 squares.

[Footnote: See Pl. VII, No. 2, the lower sketch.]

The proportions of the whole figure (338-341).

338.

A man when he lies down is reduced to 1/9 of his height.

339.

The opening of the ear, the joint of the shoulder, that of the hip and the ancle are in perpendicular lines; *a n* is equal to *m o*.

[Footnote: See Pl. XVI, No. 2, the upper sketch.]

340.

From the chin to the roots of the hair is $\frac{1}{10}$ of the whole figure. From the joint of the palm of the hand to the tip of the longest finger is $\frac{1}{10}$. From the chin to the top of the head $\frac{1}{8}$; and from the pit of the stomach to the top of the breast is $\frac{1}{6}$, and from the pit below the breast bone to the top of the head $\frac{1}{4}$. From the chin to the nostrils $\frac{1}{3}$ Part of the face, the same from the nostrils to the brow and from the brow to the roots of the hair, and the foot is $\frac{1}{6}$, the elbow $\frac{1}{4}$, the width of the shoulders $\frac{1}{4}$.

341.

The width of the shoulders is $\frac{1}{4}$ of the whole. From the joint of the shoulder to the hand is $\frac{1}{3}$, from the parting of the lips to below the shoulderblade is one foot.

The greatest thickness of a man from the breast to the spine is one 8th of his height and is equal to the space between the bottom of the chin and the top of the head.

The greatest width is at the shoulders and goes 4.

The torso from the front and back.

342.

The width of a man under the arms is the same as at the hips.

A man's width across the hips is equal to the distance from the top of the hip to the bottom of the buttock, when a man stands equally balanced on both feet; and there is the same distance from the top of the hip to the armpit. The waist, or narrower part above the hips will be half way between the arm pits and the bottom of the buttock.

[Footnote: The lower sketch Pl. XVI, No. 2, is drawn by the side of line 1.]

Vitruvius' scheme of proportions.

343.

Vitruvius, the architect, says in his work on architecture that the measurements of the human body are distributed by Nature as follows: that is that 4 fingers make 1 palm, and 4 palms make 1 foot, 6 palms make 1 cubit; 4 cubits make a man's height. And 4 cubits make one pace and 24 palms make a

man; and these measures he used in his buildings. If you open your legs so much as to decrease your height $\frac{1}{14}$ and spread and raise your arms till your middle fingers touch the level of the top of your head you must know that the centre of the outspread limbs will be in the navel and the space between the legs will be an equilateral triangle.

The length of a man's outspread arms is equal to his height.

From the roots of the hair to the bottom of the chin is the tenth of a man's height; from the bottom of the chin to the top of his head is one eighth of his height; from the top of the breast to the top of his head will be one sixth of a man. From the top of the breast to the roots of the hair will be the seventh part of the whole man. From the nipples to the top of the head will be the fourth part of a man. The greatest width of the shoulders contains in itself the fourth part of the man. From the elbow to the tip of the hand will be the fifth part of a man; and from the elbow to the angle of the armpit will be the eighth part of the man. The whole hand will be the tenth part of the man; the beginning of the genitals marks the middle of the man. The foot is the seventh part of the man. From the sole of the foot to below the knee will be the fourth part of the man. From below the knee to the beginning of the genitals will be the fourth part of the man. The distance from the bottom of the chin to the nose and from the roots of the hair to the eyebrows is, in each case the same, and like the ear, a third of the face.

[Footnote: See Pl. XVIII. The original leaf is 21 centimetres wide and $33 \frac{1}{2}$ long. At the ends of the scale below the figure are written the words *diti* (fingers) and *palmi* (palms). The passage quoted from Vitruvius is Book III, Cap. 1, and Leonardo's drawing is given in the editions of Vitruvius by FRA GIOCONDO (Venezia 1511, fol., Firenze 1513, 8vo.) and by CESARIANO (Como 1521).]

The arm and head.

344.

From *b* to *a* is one head, as well as from *c* to *a* and this happens when the elbow forms a right angle.

[Footnote: See Pl. XLI, No. 1.]

Proportions of the arm (345-349).

345.

From the tip of the longest finger of the hand to the shoulder joint is four

hands or, if you will, four faces.

a b c are equal and each interval is 2 heads.

[Footnote: Lines 1-3 are given on Pl. XV below the front view of the leg; lines 4 and 5 are below again, on the left side. The lettering refers to the bent arm near the text.]

346.

The hand from the longest finger to the wrist joint goes 4 times from the tip of the longest finger to the shoulder joint.

347.

a b c are equal to each other and to the foot and to the space between the nipple and the navel *d e* will be the third part of the whole man.

f g is the fourth part of a man and is equal to *g h* and measures a cubit.

[Footnote: See Pl. XIX, No. 1. 1. *mamolino* (= *bambino*, little child) may mean here the navel.]

348.

a b goes 4 times into *a c* and 9 into *a m*. The greatest thickness of the arm between the elbow and the hand goes 6 times into *a m* and is equal to *r f*. The greatest thickness of the arm between the shoulder and the elbow goes 4 times into *c m*, and is equal to *h n g*. The smallest thickness of the arm above the elbow *x y* is not the base of a square, but is equal to half the space *h 3* which is found between the inner joint of the arm and the wrist joint.

The width of the wrist goes 12 times into the whole arm; that is from the tip of the fingers to the shoulder joint; that is 3 times into the hand and 9 into the arm.

The arm when bent is 4 heads.

The arm from the shoulder to the elbow in bending increases in length, that is in the length from the shoulder to the elbow, and this increase is equal to the thickness of the arm at the wrist when seen in profile. And the space between the bottom of the chin and the parting of the lips, is equal to the thickness of the 2 middle fingers, and to the width of the mouth and to the space between the roots of the hair on the forehead and the top of the head [Footnote: *Queste cose*. This

passage seems to have been written on purpose to rectify the foregoing lines. The error is explained by the accompanying sketch of the bones of the arm.]. All these distances are equal to each other, but they are not equal to the above-mentioned increase in the arm.

The arm between the elbow and wrist never increases by being bent or extended.

The arm, from the shoulder to the inner joint when extended.

When the arm is extended, $p n$ is equal to $n a$. And when it is bent $n a$ diminishes $1/6$ of its length and $p n$ does the same. The outer elbow joint increases $1/7$ when bent; and thus by being bent it increases to the length of 2 heads. And on the inner side, by bending, it is found that whereas the arm from where it joins the side to the wrist, was 2 heads and a half, in bending it loses the half head and measures only two: one from the [shoulder] joint to the end [by the elbow], and the other to the hand.

The arm when folded will measure 2 faces up to the shoulder from the elbow and 2 from the elbow to the insertion of the four fingers on the palm of the hand. The length from the base of the fingers to the elbow never alters in any position of the arm.

If the arm is extended it decreases by $1/3$ of the length between b and h ; and if — being extended — it is bent, it will increase the half of $o e$. [Footnote 59-61: The figure sketched in the margin is however drawn to different proportions.] The length from the shoulder to the elbow is the same as from the base of the thumb, inside, to the elbow $a b c$.

[Footnote 62-64: The arm sketch on the margin of the MS. is identically the same as that given below on Pl. XX which may therefore be referred to in this place. In line 62 we read therefore $z c$ for $m n$.] The smallest thickness of the arm in profile $z c$ goes 6 times between the knuckles of the hand and the dimple of the elbow when extended and 14 times in the whole arm and 42 in the whole man. The greatest thickness of the arm in profile is equal to the greatest thickness of the arm in front; but the first is placed at a third of the arm from the shoulder joint to the elbow and the other at a third from the elbow towards the hand.

[Footnote: Compare Pl. XVII. Lines 1-10 and 11-15 are written in two columns below the extended arm, and at the tips of the fingers we find the words: *fine d'unghie* (ends of the nails). Part of the text — lines 22 to 25 — is visible by the side of the sketches on Pl. XXXV, No. 1.]

From the top of the shoulder to the point of the elbow is as far as from that point to the joints of the four fingers with the palm of the hand, and each is 2 faces.

a e is equal to the palm of the hand, *r f* and *o g* are equal to half a head and each goes 4 times into *a b* and *b c*. From *c* to *m* is $\frac{1}{2}$ a head; *m n* is $\frac{1}{3}$ of a head and goes 6 times into *c b* and into *b a*; *a b* loses $\frac{1}{7}$ of its length when the arm is extended; *c b* never alters; *o* will always be the middle point between *a* and *s*.

y l is the fleshy part of the arm and measures one head; and when the arm is bent this shrinks $\frac{2}{5}$ of its length; *o a* in bending loses $\frac{1}{6}$ and so does *o r*.

a b is $\frac{1}{7}$ of *r c*. *f s* will be $\frac{1}{8}$ of *r c*, and each of those 2 measurements is the largest of the arm; *k h* is the thinnest part between the shoulder and the elbow and it is $\frac{1}{8}$ of the whole arm *r c*; *o p* is $\frac{1}{5}$ of *r l*; *c z* goes 13 times into *r c*.

[Footnote: See Pl. XX where the text is also seen from lines 5-23.]

The movement of the arm (350-354).

350.

In the innermost bend of the joints of every limb the reliefs are converted into a hollow, and likewise every hollow of the innermost bends becomes a convexity when the limb is straightened to the utmost. And in this very great mistakes are often made by those who have insufficient knowledge and trust to their own invention and do not have recourse to the imitation of nature; and these variations occur more in the middle of the sides than in front, and more at the back than at the sides.

351.

When the arm is bent at an angle at the elbow, it will produce some angle; the more acute the angle is, the more will the muscles within the bend be shortened; while the muscles outside will become of greater length than before. As is shown in the example; *d c e* will shrink considerably; and *b n* will be much extended.

[Footnote: See Pl. XIX, No. 2.]

352.

OF PAINTING.

The arm, as it turns, thrusts back its shoulder towards the middle of the back.

353.

The principal movements of the hand are 10; that is forwards, backwards, to right and to left, in a circular motion, up or down, to close and to open, and to spread the fingers or to press them together.

354.

OF THE MOTIONS OF THE FINGERS.

The movements of the fingers principally consist in extending and bending them. This extension and bending vary in manner; that is, sometimes they bend altogether at the first joint; sometimes they bend, or extend, half way, at the 2nd joint; and sometimes they bend in their whole length and in all the three joints at once. If the 2 first joints are hindered from bending, then the 3rd joint can be bent with greater ease than before; it can never bend of itself, if the other joints are free, unless all three joints are bent. Besides all these movements there are 4 other principal motions of which 2 are up and down, the two others from side to side; and each of these is effected by a single tendon. From these there follow an infinite number of other movements always effected by two tendons; one tendon ceasing to act, the other takes up the movement. The tendons are made thick inside the fingers and thin outside; and the tendons inside are attached to every joint but outside they are not.

[Footnote 26: This head line has, in the original, no text to follow.] Of the strength [and effect] of the 3 tendons inside the fingers at the 3 joints.

The movement of the torso (355-361).

355.

Observe the altered position of the shoulder in all the movements of the arm, going up and down, inwards and outwards, to the back and to the front, and also in circular movements and any others.

And do the same with reference to the neck, hands and feet and the breast above the lips &c.

356.

Three are the principal muscles of the shoulder, that is *b c d*, and two are the lateral muscles which move it forward and backward, that is *a o*; *a* moves it forward, and *o* pulls it back; and *b* raises it; *a b c* moves it upwards and forwards, and *c d o* upwards and backwards. Its own weight almost suffices to move it downwards.

The muscle *d* acts with the muscle *c* when the arm moves forward; and in moving backward the muscle *b* acts with the muscle *c*.

[Footnote: See Pl. XXI. In the original the lettering has been written in ink upon the red chalk drawing and the outlines of the figures have in most places been inked over.]

357.

OF THE LOINS, WHEN BENT.

The loins or backbone being bent. The breasts are always lower than the shoulderblades of the back.

If the breast bone is arched the breasts are higher than the shoulderblades.

If the loins are upright the breast will always be found at the same level as the shoulderblades.

[Footnote: See Pl. XXII, No. 1.]

358.

a b the tendon and ankle in raising the heel approach each other by a finger's breadth; in lowering it they separate by a finger's breadth.

[Footnote: See Pl. XXII, No. 2. Compare this facsimile and text with Pl. III, No. 2, and p. 152 of MANZI'S edition. Also with No. 274 of LUDWIG'S edition of the Vatican Copy.]

359.

Just so much as the part *d a* of the nude figure decreases in this position so much does the opposite part increase; that is: in proportion as the length of the part *d a* diminishes the normal size so does the opposite upper part increase beyond its [normal] size. The navel does not change its position to the male organ; and this shrinking arises because when a figure stands on one foot, that foot becomes the centre [of gravity] of the superimposed weight. This being so, the middle between the shoulders is thrust above it out of its perpendicular line, and this line, which forms the central line of the external parts of the body, becomes bent at its upper extremity [so as to be] above the foot which supports the body; and the transverse lines are forced into such angles that their ends are lower on the side which is supported. As is shown at *a b c*.

[Footnote: See Pl. XXII, No. 3.]

360.

OF PAINTING.

Note in the motions and attitudes of figures how the limbs vary, and their feeling, for the shoulderblades in the motions of the arms and shoulders vary the [line of the] back bone very much. And you will find all the causes of this in my book of Anatomy.

361.

OF [CHANGE OF] ATTITUDE.

The pit of the throat is over the feet, and by throwing one arm forward the pit of the throat is thrown off that foot. And if the leg is thrown forward the pit of the throat is thrown forward; and. so it varies in every attitude.

362.

OF PAINTING.

Indicate which are the muscles, and which the tendons, which become prominent or retreat in the different movements of each limb; or which do neither [but are passive]. And remember that these indications of action are of the first importance and necessity in any painter or sculptor who professes to be a master &c.

And indicate the same in a child, and from birth to decrepitude at every stage of its life; as infancy, childhood, boyhood, youth &c.

And in each express the alterations in the limbs and joints, which swell and which grow thinner.

363.

O Anatomical Painter! beware lest the too strong indication of the bones, sinews and muscles, be the cause of your becoming wooden in your painting by your wish to make your nude figures display all their feeling. Therefore, in endeavouring to remedy this, look in what manner the muscles clothe or cover their bones in old or lean persons; and besides this, observe the rule as to how these same muscles fill up the spaces of the surface that extend between them, which are the muscles which never lose their prominence in any amount of fatness; and which too are the muscles of which the attachments are lost to sight in the very least plumpness. And in many cases several muscles look like one single muscle in the increase of fat; and in many cases, in growing lean or old, one single muscle divides into several muscles. And in this treatise, each in its place, all their peculiarities will be explained — and particularly as to the spaces between the joints of each limb &c. Again, do not fail [to observe] the variations in the forms of the above mentioned muscles, round and about the joints of the limbs of any animal, as caused by the diversity of the motions of each limb; for

on some side of those joints the prominence of these muscles is wholly lost in the increase or diminution of the flesh of which these muscles are composed, &c.

[Footnote: DE ROSSI remarks on this chapter, in the Roman edition of the Trattato, p. 504: “*Non in questo luogo solo, ma in altri ancora osserverà il lettore, che Lionardo va fungendo quelli che fanno abuso della loro dottrina anatomica, e sicuramente con ciò ha in mira il suo rivale Bonarroiti, che di anatomia facea tanta pompa.*” Note, that Leonardo wrote this passage in Rome, probably under the immediate impression of MICHAELANGELO’S paintings in the Sistine Chapel and of RAPHAEL’S Isaiah in Sant’ Agostino.]

364.

OF THE DIFFERENT MEASUREMENTS OF BOYS AND MEN.

There is a great difference in the length between the joints in men and boys for, in man, from the top of the shoulder [by the neck] to the elbow, and from the elbow to the tip of the thumb and from one shoulder to the other, is in each instance two heads, while in a boy it is but one because Nature constructs in us the mass which is the home of the intellect, before forming that which contains the vital elements.

365.

OF PAINTING.

Which are the muscles which subdivide in old age or in youth, when becoming lean? Which are the parts of the limbs of the human frame where no amount of fat makes the flesh thicker, nor any degree of leanness ever diminishes it?

The thing sought for in this question will be found in all the external joints of the bones, as the shoulder, elbow, wrists, finger-joints, hips, knees, ankle-bone and toes and the like; all of which shall be told in its place. The greatest thickness acquired by any limb is at the part of the muscles which is farthest

from its attachments.

Flesh never increases on those portions of the limb where the bones are near to the surface.

At *b r d a c e f* the increase or diminution of the flesh never makes any considerable difference. Nature has placed in front of man all those parts which feel most pain under a blow; and these are the shin of the leg, the forehead, and the nose. And this was done for the preservation of man, since, if such pain were not felt in these parts, the number of blows to which they would be exposed must be the cause of their destruction.

Describe why the bones of the arm and leg are double near the hand and foot [respectively].

And where the flesh is thicker or thinner in the bending of the limbs.

366.

OF PAINTING.

Every part of the whole must be in proportion to the whole. Thus, if a man is of a stout short figure he will be the same in all his parts: that is with short and thick arms, wide thick hands, with short fingers with their joints of the same character, and so on with the rest. I would have the same thing understood as applying to all animals and plants; in diminishing, [the various parts] do so in due proportion to the size, as also in enlarging.

367.

OF THE AGREEMENT OF THE PROPORTION OF THE LIMBS.

And again, remember to be very careful in giving your figures limbs, that they must appear to agree with the size of the body and likewise to the age. Thus a youth has limbs that are not very muscular not strongly veined, and the surface is delicate and round, and tender in colour. In man the limbs are sinewy and muscular, while in old men the surface is wrinkled, rugged and knotty, and the

sinews very prominent.

HOW YOUNG BOYS HAVE THEIR JOINTS JUST THE REVERSE OF THOSE OF MEN, AS TO SIZE.

Little children have all the joints slender and the portions between them are thick; and this happens because nothing but the skin covers the joints without any other flesh and has the character of sinew, connecting the bones like a ligature. And the fat fleshiness is laid on between one joint and the next, and between the skin and the bones. But, since the bones are thicker at the joints than between them, as a mass grows up the flesh ceases to have that superfluity which it had, between the skin and the bones; whence the skin clings more closely to the bone and the limbs grow more slender. But since there is nothing over the joints but the cartilaginous and sinewy skin this cannot dry up, and, not drying up, cannot shrink. Thus, and for this reason, children are slender at the joints and fat between the joints; as may be seen in the joints of the fingers, arms, and shoulders, which are slender and dimpled, while in man on the contrary all the joints of the fingers, arms, and legs are thick; and wherever children have hollows men have prominences.

The movement of the human figure (368-375).

368.

Of the manner of representing the 18 actions of man. Repose, movement, running, standing, supported, sitting, leaning, kneeling, lying down, suspended. Carrying or being carried, thrusting, pulling, striking, being struck, pressing down and lifting up.

[As to how a figure should stand with a weight in its hand [Footnote 8: The original text ends here.] Remember].

369.

A sitting man cannot raise himself if that part of his body which is front of his axis [centre of gravity] does not weigh more than that which is behind that axis [or centre] without using his arms.

A man who is mounting any slope finds that he must involuntarily throw the most weight forward, on the higher foot, rather than behind — that is in front of the axis and not behind it. Hence a man will always, involuntarily, throw the greater weight towards the point whither he desires to move than in any other direction.

The faster a man runs, the more he leans forward towards the point he runs to and throws more weight in front of his axis than behind. A man who runs down hill throws the axis onto his heels, and one who runs up hill throws it into the points of his feet; and a man running on level ground throws it first on his heels and then on the points of his feet.

This man cannot carry his own weight unless, by drawing his body back he balances the weight in front, in such a way as that the foot on which he stands is the centre of gravity.

[Footnote: See Pl. XXII, No. 4.]

370.

How a man proceeds to raise himself to his feet, when he is sitting on level ground.

371.

A man when walking has his head in advance of his feet.

A man when walking across a long level plain first leans [rather] backwards and then as much forwards.

[Footnote 3-6: He strides forward with the air of a man going down hill; when weary, on the contrary he walks like a man going up hill.]

372.

A man when running throws less weight on his legs than when standing still. And in the same way a horse which is running feels less the weight of the man he carries. Hence many persons think it wonderful that, in running, the horse can rest on one single foot. From this it may be stated that when a weight is in progressive motion the more rapid it is the less is the perpendicular weight towards the centre.

373.

If a man, in taking a jump from firm ground, can leap 3 braccia, and when he was taking his leap it were to recede $\frac{1}{3}$ of a braccio, that would be taken off his former leap; and so if it were thrust forward $\frac{1}{3}$ of a braccio, by how much would his leap be increased?

374.

OF DRAWING.

When a man who is running wants to neutralise the impetus that carries him on he prepares a contrary impetus which is generated by his hanging backwards. This can be proved, since, if the impetus carries a moving body with a momentum equal to 4 and the moving body wants to turn and fall back with a momentum of 4, then one momentum neutralises the other contrary one, and the impetus is neutralised.

Of walking up and down (375-379)

375.

When a man wants to stop running and check the impetus he is forced to hang back and take short quick steps. [Footnote: Lines 5-31 refer to the two upper figures, and the lower figure to the right is explained by the last part of the chapter.] The centre of gravity of a man who lifts one of his feet from the ground always rests on the centre of the sole of the foot [he stands on].

A man, in going up stairs involuntarily throws so much weight forward and on the side of the upper foot as to be a counterpoise to the lower leg, so that the labour of this lower leg is limited to moving itself.

The first thing a man does in mounting steps is to relieve the leg he is about to lift of the weight of the body which was resting on that leg; and besides this, he gives to the opposite leg all the rest of the bulk of the whole man, including [the weight of] the other leg; he then raises the other leg and sets the foot upon the step to which he wishes to raise himself. Having done this he restores to the

upper foot all the weight of the body and of the leg itself, and places his hand on his thigh and throws his head forward and repeats the movement towards the point of the upper foot, quickly lifting the heel of the lower one; and with this impetus he lifts himself up and at the same time extends the arm which rested on his knee; and this extension of the arm carries up the body and the head, and so straightens the spine which was curved.

The higher the step is which a man has to mount, the farther forward will he place his head in advance of his upper foot, so as to weigh more on *a* than on *b*; this man will not be on the step *m*. As is shown by the line *g f*.

[Footnote: See Pl. XXIII, No. 1. The lower sketch to the left belongs to the four first lines.]

376.

I ask the weight [pressure] of this man at every degree of motion on these steps, what weight he gives to *b* and to *c*.

[Footnote 8: These lines are, in the original, written in ink] Observe the perpendicular line below the centre of gravity of the man.

[Footnote: See Pl. XXIII, No. 2.]

377.

In going up stairs if you place your hands on your knees all the labour taken by the arms is removed from the sinews at the back of the knees.

[Footnote: See Pl. XXIII, No. 3.]

378.

The sinew which guides the leg, and which is connected with the patella of the knee, feels it a greater labour to carry the man upwards, in proportion as the leg is more bent; and the muscle which acts upon the angle made by the thigh where it joins the body has less difficulty and has a less weight to lift, because it has not the [additional] weight of the thigh itself. And besides this it has stronger muscles, being those which form the buttock.

379.

A man coming down hill takes little steps, because the weight rests upon the hinder foot, while a man mounting takes wide steps, because his weight rests on the foremost foot.

[Footnote: See Pl. XXIII, No. 4.]

On the human body in action (380-388).

380.

OF THE HUMAN BODY IN ACTION.

When you want to represent a man as moving some weight consider what the movements are that are to be represented by different lines; that is to say either from below upwards, with a simple movement, as a man does who stoops forward to take up a weight which he will lift as he straightens himself. Or as a man does who wants to squash something backwards, or to force it forwards or to pull it downwards with ropes passed through pullies [Footnote 10: Compare the sketch on page 198 and on 201 (S. K. M. II.1 86b).]. And here remember that the weight of a man pulls in proportion as his centre of gravity is distant from his fulcrum, and to this is added the force given by his legs and bent back as he raises himself.

381.

Again, a man has even a greater store of strength in his legs than he needs for his own weight; and to see if this is true, make a man stand on the shore-sand and then put another man on his back, and you will see how much he will sink in. Then take the man from off his back and make him jump straight up as high as he can, and you will find that the print of his feet will be made deeper by the jump than from having the man on his back. Hence, here, by 2 methods it is proved that a man has double the strength he requires to support his own body.

382.

OF PAINTING.

If you have to draw a man who is in motion, or lifting or pulling, or carrying a weight equal to his own, in what way must you set on his legs below his body?

[Footnote: In the MS. this question remains unanswered.]

383.

OF THE STRENGTH OF MAN.

A man pulling a [dead] weight balanced against himself cannot pull more than his own weight. And if he has to raise it he will [be able to] raise as much more than his weight as his strength may be more than that of other men. [Footnote 7: The stroke at the end of this line finishes in the original in a sort of loop or flourish, and a similar flourish occurs at the end of the previous passage written on the same page. M. RAVAISSON regards these as numbers (compare the photograph of page 30b in his edition of MS. A). He remarks: "*Ce chiffre 8 et, a la fin de l'alea precedent, le chiffre 7 sont, dans le manuscrit, des renvois.*"] The greatest force a man can apply, with equal velocity and impetus, will be when he sets his feet on one end of the balance [or lever] and then presses his shoulders against some stable body. This will raise a weight at the other end of the balance [lever], equal to his own weight and [added to that] as much weight as he can carry on his shoulders.

384.

No animal can simply move [by its dead weight] a greater weight than the sum of its own weight outside the centre of his fulcrum.

385.

A man who wants to send an arrow very far from the bow must be standing entirely on one foot and raising the other so far from the foot he stands on as to

afford the requisite counterpoise to his body which is thrown on the front foot. And he must not hold his arm fully extended, and in order that he may be more able to bear the strain he must hold a piece of wood which there is in all crossbows, extending from the hand to the breast, and when he wishes to shoot he suddenly leaps forward at the same instant and extends his arm with the bow and releases the string. And if he dexterously does every thing at once it will go a very long way.

386.

When two men are at the opposite ends of a plank that is balanced, and if they are of equal weight, and if one of them wants to make a leap into the air, then his leap will be made down from his end of the plank and the man will never go up again but must remain in his place till the man at the other end dashes up the board.

[Footnote: See Pl. XXIV, No. 3.]

387.

Of delivering a blow to the right or left.

[Footnote: Four sketches on Pl. XXIV, No. 1 belong to this passage. The rest of the sketches and notes on that page are of a miscellaneous nature.]

388.

Why an impetus is not spent at once [but diminishes] gradually in some one direction? [Footnote 1: The paper has been damaged at the end of line 1.] The impetus acquired in the line *a b c d* is spent in the line *d e* but not so completely but that some of its force remains in it and to this force is added the momentum in the line *d e* with the force of the motive power, and it must follow that the impetus multiplied by the blow is greater than the simple impetus produced by the momentum *d e*.

[Footnote 8: The sketch No. 2 on Pl. XXIV stands, in the original, between lines 7 and 8. Compare also the sketches on Pl. LIV.] A man who has to deal a great blow with his weapon prepares himself with all his force on the opposite side to that where the spot is which he is to hit; and this is because a body as it

gains in velocity gains in force against the object which impedes its motion.
On hair falling down in curls.

389.

Observe the motion of the surface of the water which resembles that of hair, and has two motions, of which one goes on with the flow of the surface, the other forms the lines of the eddies; thus the water forms eddying whirlpools one part of which are due to the impetus of the principal current and the other to the incidental motion and return flow.

[Footnote: See Pl. XXV. Where also the text of this passage is given in facsimile.]

On draperies (390 — 392).

390.

OF THE NATURE OF THE FOLDS IN DRAPERY.

That part of a fold which is farthest from the ends where it is confined will fall most nearly in its natural form.

Every thing by nature tends to remain at rest. Drapery, being of equal density and thickness on its wrong side and on its right, has a tendency to lie flat; therefore when you give it a fold or plait forcing it out of its flatness note well the result of the constraint in the part where it is most confined; and the part which is farthest from this constraint you will see relapses most into the natural state; that is to say lies free and flowing.

EXAMPLE.

[Footnote 13: *a c sia*. In the original text *b* is written instead of *c* — an evident slip of the pen.] Let *a b c* be the fold of the drapery spoken of above, *a c* will be the places where this folded drapery is held fast. I maintain that the part of the drapery which is farthest from the plaited ends will revert most to its natural form.

Therefore, *b* being farthest from *a* and *c* in the fold *a b c* it will be wider there than anywhere else.

[Footnote: See Pl. XXVIII, No. 6, and compare the drawing from Windsor Pl. XXX for farther illustration of what is here stated.]

391.

OF SMALL FOLDS IN DRAPERIES.

How figures dressed in a cloak should not show the shape so much as that the cloak looks as if it were next the flesh; since you surely cannot wish the cloak to be next the flesh, for you must suppose that between the flesh and the cloak there are other garments which prevent the forms of the limbs appearing distinctly through the cloak. And those limbs which you allow to be seen you must make thicker so that the other garments may appear to be under the cloak. But only give something of the true thickness of the limbs to a nymph [Footnote 9: *Una nifa*. Compare the beautiful drawing of a Nymph, in black chalk from the Windsor collection, Pl. XXVI.] or an angel, which are represented in thin draperies, pressed and clinging to the limbs of the figures by the action of the wind.

392.

You ought not to give to drapery a great confusion of many folds, but rather only introduce them where they are held by the hands or the arms; the rest you may let fall simply where it is its nature to flow; and do not let the nude forms be broken by too many details and interrupted folds. How draperies should be drawn from nature: that is to say if you want to represent woollen cloth draw the folds from that; and if it is to be silk, or fine cloth or coarse, or of linen or of crape, vary the folds in each and do not represent dresses, as many do, from models covered with paper or thin leather which will deceive you greatly.

[Footnote: The little pen and ink drawing from Windsor (W. 102), given on Pl. XXVIII, No. 7, clearly illustrates the statement made at the beginning of this passage; the writing of the cipher 19 on the same page is in Leonardo's hand; the cipher 21 is certainly not.]

VIII. BOTANY FOR PAINTERS AND ELEMENTS OF LANDSCAPE PAINTING.

The chapters composing this portion of the work consist of observations on Form, Light and Shade in Plants, and particularly in Trees summed up in certain general rules by which the author intends to guide the artist in the pictorial representation of landscape.

With these the first principles of a Theory of Landscape painting are laid down — a theory as profoundly thought out in its main lines as it is lucidly worked out in its details. In reading these chapters the conviction is irresistible that such a Botany for painters is or ought to be of similar importance in the practice of painting as the principles of the Proportions and Movements of the human figure i. e. Anatomy for painters.

There can be no doubt that Leonardo, in laying down these rules, did not intend to write on Botany in the proper scientific sense — his own researches on that subject have no place here; it need only be observed that they are easily distinguished by their character and contents from those which are here collected and arranged under the title 'Botany for painters'. In some cases where this division might appear doubtful, — as for instance in No. 402 — the Painter is directly addressed and enjoined to take the rule to heart as of special importance in his art.

The original materials are principally derived from MS. G, in which we often find this subject treated on several pages in succession without any of that intermixture of other matters, which is so frequent in Leonardo's writings. This MS., too, is one of the latest; when it was written, the great painter was already more than sixty years of age, so we can scarcely doubt that he regarded all he wrote as his final views on the subject. And the same remark applies to the chapters from MSS. E and M which were also written between 1513 — 15.

For the sake of clearness, however, it has been desirable to sacrifice — with few exceptions — the original order of the passages as written, though it was with much reluctance and only after long hesitation that I resigned myself to this necessity. Nor do I mean to impugn the logical connection of the author's ideas in his MS.; but it will be easily understood that the sequence of disconnected notes, as they occurred to Leonardo and were written down from time to time,

might be hardly satisfactory as a systematic arrangement of his principles. The reader will find in the Appendix an exact account of the order of the chapters in the original MS. and from the data there given can restore them at will. As the materials are here arranged, the structure of the tree as regards the growth of the branches comes first (394-411) and then the insertion of the leaves on the stems (412-419). Then follow the laws of Light and Shade as applied, first, to the leaves (420-434), and, secondly, to the whole tree and to groups of trees (435-457). After the remarks on the Light and Shade in landscapes generally (458-464), we find special observations on that of views of towns and buildings (465-469). To the theory of Landscape Painting belong also the passages on the effect of Wind on Trees (470-473) and on the Light and Shade of Clouds (474-477), since we find in these certain comparisons with the effect of Light and Shade on Trees (e. g.: in No. 476, 4. 5; and No. 477, 9. 12). The chapters given in the Appendix Nos. 478 and 481 have hardly any connection with the subjects previously treated.

Classification of trees.

393.

TREES.

Small, lofty, straggling, thick, that is as to foliage, dark, light, russet, branched at the top; some directed towards the eye, some downwards; with white stems; this transparent in the air, that not; some standing close together, some scattered.

The relative thickness of the branches to the trunk (393 — 396).

394.

All the branches of a tree at every stage of its height when put together are equal in thickness to the trunk [below them].

All the branches of a water [course] at every stage of its course, if they are of equal rapidity, are equal to the body of the main stream.

395.

Every year when the boughs of a plant [or tree] have made an end of maturing their growth, they will have made, when put together, a thickness equal to that of the main stem; and at every stage of its ramification you will find the thickness of the said main stem; as: *i k, g h, e f, c d, a b*, will always be equal to each other; unless the tree is pollard — if so the rule does not hold good.

All the branches have a direction which tends to the centre of the tree *m*.

[Footnote: The two sketches of leafless trees one above another on the left hand side of Pl. XXVII, No. 1, belong to this passage.]

396.

If the plant *n* grows to the thickness shown at *m*, its branches will correspond [in thickness] to the junction *a b* in consequence of the growth inside as well as outside.

The branches of trees or plants have a twist wherever a minor branch is given off; and this giving off the branch forms a fork; this said fork occurs between two angles of which the largest will be that which is on the side of the larger branch, and in proportion, unless accident has spoilt it.

[Footnote: The sketches illustrating this are on the right hand side of Pl. XXVII, No. I, and the text is also given there in facsimile.]

397.

There is no boss on branches which has not been produced by some branch which has failed.

The lower shoots on the branches of trees grow more than the upper ones and this occurs only because the sap that nourishes them, being heavy, tends downwards more than upwards; and again, because those [branches] which grow downwards turn away from the shade which exists towards the centre of the plant. The older the branches are, the greater is the difference between their upper and their lower shoots and in those dating from the same year or epoch.

[Footnote: The sketch accompanying this in the MS. is so effaced that an exact reproduction was impossible.]

398.

OF THE SCARS ON TREES.

The scars on trees grow to a greater thickness than is required by the sap of the limb which nourishes them.

399.

The plant which gives out the smallest ramifications will preserve the straightest line in the course of its growth.

[Footnote: This passage is illustrated by two partly effaced sketches. One of these closely resembles the lower one given under No. 408, the other also represents short closely set boughs on an upright trunk.]

400.

OF THE RAMIFICATION.

The beginning of the ramification [the shoot] always has the central line [axis] of its thickness directed to the central line [axis] of the plant itself.

401.

In starting from the main stem the branches always form a base with a prominence as is shown at *a b c d*.

402.

WHY, VERY FREQUENTLY, TIMBER HAS VEINS THAT ARE NOT STRAIGHT.

When the branches which grow the second year above the branch of the preceding year, are not of equal thickness above the antecedent branches, but are on one side, then the vigour of the lower branch is diverted to nourish the one above it, although it may be somewhat on one side.

But if the ramifications are equal in their growth, the veins of the main stem will be straight [parallel] and equidistant at every degree of the height of the plant.

Wherefore, O Painter! you, who do not know these laws! in order to escape the blame of those who understand them, it will be well that you should represent every thing from nature, and not despise such study as those do who work [only] for money.

The direction of growth (403-407).

403.

OF THE RAMIFICATIONS OF PLANTS.

The plants which spread very much have the angles of the spaces which divide their branches more obtuse in proportion as their point of origin is lower down; that is nearer to the thickest and oldest portion of the tree. Therefore in the youngest portions of the tree the angles of ramification are more acute. [Footnote: Compare the sketches on the lower portion of Pl. XXVII, No. 2.]

404.

The tips of the boughs of plants [and trees], unless they are borne down by the weight of their fruits, turn towards the sky as much as possible.

The upper side of their leaves is turned towards the sky that it may receive the nourishment of the dew which falls at night.

The sun gives spirit and life to plants and the earth nourishes them with moisture. With regard to this I made the experiment of leaving only one small root on a gourd and this I kept nourished with water, and the gourd brought to perfection all the fruits it could produce, which were about 60 gourds of the long kind, and I set my mind diligently [to consider] this vitality and perceived that the dews of night were what supplied it abundantly with moisture through the insertion of its large leaves and gave nourishment to the plant and its offspring — or the seeds which its offspring had to produce — .

The rule of the leaves produced on the last shoot of the year will be that they will grow in a contrary direction on the twin branches; that is, that the insertion of the leaves turns round each branch in such a way, as that the sixth leaf above is produced over the sixth leaf below, and the way they turn is that if one turns towards its companion to the right, the other turns to the left, the leaf serving as the nourishing breast for the shoot or fruit which grows the following year.

[Footnote: A French translation of lines 9-12 was given by M. RAVAISSON in the *Gazette des Beaux Arts*, Oct. 1877; his paper also contains some valuable information as to botanical science in the ancient classical writers and at the time of the Renaissance.]

405.

The lowest branches of those trees which have large leaves and heavy fruits, such as nut-trees, fig-trees and the like, always droop towards the ground.

The branches always originate above [in the axis of] the leaves.

406.

The upper shoots of the lateral branches of plants lie closer to the parent branch than the lower ones.

407.

The lowest branches, after they have formed the angle of their separation from the parent stem, always bend downwards so as not to crowd against the other branches which follow them on the same stem and to be better able to take the air which nourishes them. As is shown by the angle $b a c$; the branch $a c$ after it has made the corner of the angle $a c$ bends downwards to $c d$ and the lesser shoot c dries up, being too thin.

The main branch always goes below, as is shown by the branch $f n m$, which does not go to $f n o$.

The forms of trees (408 — 411).

408.

The elm always gives a greater length to the last branches of the year's growth than to the lower ones; and Nature does this because the highest branches are those which have to add to the size of the tree; and those at the bottom must get dry because they grow in the shade and their growth would be an impediment to the entrance of the solar rays and the air among the main branches of the tree.

The main branches of the lower part bend down more than those above, so as to be more oblique than those upper ones, and also because they are larger and older.

409.

In general almost all the upright portions of trees curve somewhat turning the convexity towards the South; and their branches are longer and thicker and more abundant towards the South than towards the North. And this occurs because the sun draws the sap towards that surface of the tree which is nearest to it.

And this may be observed if the sun is not screened off by other plants.

410.

The cherry-tree is of the character of the fir tree as regards its ramification placed in stages round its main stem; and its branches spring, 4 or five or 6 [together] opposite each other; and the tips of the topmost shoots form a pyramid from the middle upwards; and the walnut and oak form a hemisphere from the middle upwards.

411.

The bough of the walnut which is only hit and beaten when it has brought to perfection...

[Footnote: The end of the text and the sketch in red chalk belonging to it, are entirely effaced.]

The insertion of the leaves (412 — 419).

412.

OF THE INSERTION OF THE BRANCHES ON PLANTS.

Such as the growth of the ramification of plants is on their principal branches, so is that of the leaves on the shoots of the same plant. These leaves have [Footnote 6: *Quattro modi* (four modes). Only three are described in the text, the fourth is only suggested by a sketch.

This passage occurs in MANZI'S edition of the Trattato, p. 399, but without the sketches and the text is mutilated in an important part. The whole passage has been commented on, from MANZI'S version, in Part I of the *Nuovo Giornale Botanico Italiano*, by Prof. G. UZIELLI (Florence 1869, Vol. I). He remarks as to the 'four modes': "*Leonardo, come si vede nelle linie sententi da solo tre esempi. Questa ed altre inessattezze fanno desiderare, sia esaminato di nuovo il manoscritto Vaticano*". This has since been done by D. KNAPP of Tübingen, and his accurate copy has been published by H. LUDWIG, the painter. The passage in question occurs in his edition as No. 833; and there also the drawings are wanting. The space for them has been left vacant, but in the Vatican copy '*niente*' has been written on the margin; and in it, as well as in LUDWIG'S and MANZI'S edition, the text is mutilated.] four modes of growing one above another. The first, which is the most general, is that the sixth always originates over the sixth below [Footnote 8: *la sesta di sotto. "Disposizione 2/5 o 1/5. Leonardo osservo probabilmente soltanto la prima"* (UZIELLI).]; the second is that two third ones above are over the two third ones below [Footnote 10: *terze di sotto: "Intende qui senza dubbio parlare di foglie decussate, in cui il terzo verticello e nel piano del primo"* (UZIELLI).]; and the third way is that the third above is over the third below [Footnote 11: *3a di sotto: "Disposizione 1/2"* (UZIELLI).].

[Footnote: See the four sketches on the upper portion of the page reproduced as fig. 2 on P1. XXVII.]

413.

A DESCRIPTION OF THE ELM.

The ramification of the elm has the largest branch at the top. The first and the last but one are smaller, when the main trunk is straight.

The space between the insertion of one leaf to the rest is half the extreme length of the leaf or somewhat less, for the leaves are at an interval which is about the 3rd of the width of the leaf.

The elm has more leaves near the top of the boughs than at the base; and the broad [surface] of the leaves varies little as to [angle and] aspect.

[Footnote: See Pl. XXVII, No. 3. Above the sketch and close under the number of the page is the word '*olmo*' (elm).]

414.

In the walnut tree the leaves which are distributed on the shoots of this year are further apart from each other and more numerous in proportion as the branch from which this shoot springs is a young one. And they are inserted more closely and less in number when the shoot that bears them springs from an old branch. Its fruits are borne at the ends of the shoots. And its largest boughs are the lowest on the boughs they spring from. And this arises from the weight of its sap which is more apt to descend than to rise, and consequently the branches which spring from them and rise towards the sky are small and slender ; and when the shoot turns towards the sky its leaves spread out from it [at an angle] with an equal distribution of their tips; and if the shoot turns to the horizon the leaves lie flat; and this arises from the fact that leaves without exception, turn their underside to the earth .

The shoots are smaller in proportion as they spring nearer to the base of the bough they spring from.

[Footnote: See the two sketches on Pl XXVII, No. 4. The second refers to the passage lines 20-30.]

415.

OF THE INSERTION OF THE LEAVES ON THE BRANCHES.

The thickness of a branch never diminishes within the space between one leaf and the next excepting by so much as the thickness of the bud which is above the

leaf and this thickness is taken off from the branch above [the node] as far as the next leaf.

Nature has so placed the leaves of the latest shoots of many plants that the sixth leaf is always above the first, and so on in succession, if the rule is not [accidentally] interfered with; and this occurs for two useful ends in the plant: First that as the shoot and the fruit of the following year spring from the bud or eye which lies above and in close contact with the insertion of the leaf [in the axil], the water which falls upon the shoot can run down to nourish the bud, by the drop being caught in the hollow [axil] at the insertion of the leaf. And the second advantage is, that as these shoots develop in the following year one will not cover the next below, since the 5 come forth on five different sides; and the sixth which is above the first is at some distance.

416.

OF THE RAMIFICATIONS OF TREES AND THEIR FOLIAGE.

The ramifications of any tree, such as the elm, are wide and slender after the manner of a hand with spread fingers, foreshortened. And these are seen in the distribution [thus]: the lower portions are seen from above; and those that are above are seen from below; and those in the middle, some from below and some from above. The upper part is the extreme [top] of this ramification and the middle portion is more foreshortened than any other of those which are turned with their tips towards you. And of those parts of the middle of the height of the tree, the longest will be towards the top of the tree and will produce a ramification like the foliage of the common willow, which grows on the banks of rivers.

Other ramifications are spherical, as those of such trees as put forth their shoots and leaves in the order of the sixth being placed above the first. Others are thin and light like the willow and others.

417.

You will see in the lower branches of the elder, which puts forth leaves two and two placed crosswise [at right angles] one above another, that if the stem

rises straight up towards the sky this order never fails; and its largest leaves are on the thickest part of the stem and the smallest on the slenderest part, that is towards the top. But, to return to the lower branches, I say that the leaves on these are placed on them crosswise like [those on] the upper branches; and as, by the law of all leaves, they are compelled to turn their upper surface towards the sky to catch the dew at night, it is necessary that those so placed should twist round and no longer form a cross.

[Footnote: See Pl. XXVII, No. 5.]

418.

A leaf always turns its upper side towards the sky so that it may the better receive, on all its surface, the dew which drops gently from the atmosphere. And these leaves are so distributed on the plant as that one shall cover the other as little as possible, but shall lie alternately one above another as may be seen in the ivy which covers the walls. And this alternation serves two ends; that is, to leave intervals by which the air and sun may penetrate between them. The 2nd reason is that the drops which fall from the first leaf may fall onto the fourth or — in other trees — onto the sixth.

419.

Every shoot and every fruit is produced above the insertion [in the axil] of its leaf which serves it as a mother, giving it water from the rain and moisture from the dew which falls at night from above, and often it protects them against the too great heat of the rays of the sun.

LIGHT ON BRANCHES AND LEAVES (420 — 422).

420.

That part of the body will be most illuminated which is hit by the luminous ray coming between right angles.

[Footnote: See Pl. XXVIII, No. 1.]

421.

Young plants have more transparent leaves and a more lustrous bark than old ones; and particularly the walnut is lighter coloured in May than in September.

422.

OF THE ACCIDENTS OF COLOURING IN TREES.

The accidents of colour in the foliage of trees are 4. That is: shadow, light, lustre [reflected light] and transparency.

OF THE VISIBILITY OF THESE ACCIDENTS.

These accidents of colour in the foliage of trees become confused at a great distance and that which has most breadth [whether light or shade, &c.] will be most conspicuous.

The proportions of light and shade in a leaf (423-426).

423.

OF THE SHADOWS OF A LEAF.

Sometimes a leaf has three accidents [of light] that is: shade, lustre [reflected light] and transparency [transmitted light]. Thus, if the light were at n as regards the leaf s , and the eye at m , it would see a in full light, b in shadow and c transparent.

424.

A leaf with a concave surface seen from the under side and up-side-down will sometimes show itself as half in shade, and half transparent. Thus, if *o p* is the leaf and the light *m* and the eye *n*, this will see *o* in shadow because the light does not fall upon it between equal angles, neither on the upper nor the under side, and *p* is lighted on the upper side and the light is transmitted to its under side. [Footnote: See Pl. XXVIII, No. 2, the upper sketch on the page. In the original they are drawn in red chalk.]

425.

Although those leaves which have a polished surface are to a great extent of the same colour on the right side and on the reverse, it may happen that the side which is turned towards the atmosphere will have something of the colour of the atmosphere; and it will seem to have more of this colour of the atmosphere in proportion as the eye is nearer to it and sees it more foreshortened. And, without exception the shadows show as darker on the upper side than on the lower, from the contrast offered by the high lights which limit the shadows.

The under side of the leaf, although its colour may be in itself the same as that of the upper side, shows a still finer colour — a colour that is green verging on yellow — and this happens when the leaf is placed between

426.

the eye and the light which falls upon it from the opposite side.

And its shadows are in the same positions as those were of the opposite side. Therefore, O Painter! when you do trees close at hand, remember that if the eye is almost under the tree you will see its leaves [some] on the upper and [some] on the under side, and the upper side will be bluer in proportion as they are seen more foreshortened, and the same leaf sometimes shows part of the right side and part of the under side, whence you must make it of two colours.

Of the transparency of leaves (427-429).

427.

The shadows in transparent leaves seen from the under side are the same shadows as there are on the right side of this leaf, they will show through to the

underside together with lights, but the lustre [reflected light] can never show through.

428.

When one green has another [green] behind it, the lustre on the leaves and their transparent [lights] show more strongly than in those which are [seen] against the brightness of the atmosphere.

And if the sun illuminates the leaves without their coming between it and the eye and without the eye facing the sun, then the reflected lights and the transparent lights are very strong.

It is very effective to show some branches which are low down and dark and so set off the illuminated greens which are at some distance from the dark greens seen below. That part is darkest which is nearest to the eye or which is farthest from the luminous atmosphere.

429.

Never paint leaves transparent to the sun, because they are confused; and this is because on the transparency of one leaf will be seen the shadow of another leaf which is above it. This shadow has a distinct outline and a certain depth of shade and sometimes is [as much as] half or a third of the leaf which is shaded; and consequently such an arrangement is very confused and the imitation of it should be avoided.

The light shines least through a leaf when it falls upon it at an acute angle.

The gradations of shade and colour in leaves (430-434).

430.

The shadows of plants are never black, for where the atmosphere penetrates there can never be utter darkness.

431.

If the light comes from m and the eye is at n the eye will see the colour of the

leaves *a b* all affected by the colour of *m* — that is of the atmosphere; and *b c* will be seen from the under side as transparent, with a beautiful green colour verging on yellow.

If *m* is the luminous body lighting up the leaf *s* all the eyes that see the under side of this leaf will see it of a beautiful light green, being transparent.

In very many cases the positions of the leaves will be without shadow [or in full light], and their under side will be transparent and the right side lustrous [reflecting light].

432.

The willow and other similar trees, which have their boughs lopped every 3 or 4 years, put forth very straight branches, and their shadow is about the middle where these boughs spring; and towards the extreme ends they cast but little shade from having small leaves and few and slender branches. Hence the boughs which rise towards the sky will have but little shade and little relief; and the branches which are at an angle from the horizon, downwards, spring from the dark part of the shadow and grow thinner by degrees up to their ends, and these will be in strong relief, being in gradations of light against a background of shadow.

That tree will have the least shadow which has the fewest branches and few leaves.

433.

OF DARK LEAVES IN FRONT OF TRANSPARENT ONES.

When the leaves are interposed between the light and the eye, then that which is nearest to the eye will be the darkest, and the most distant will be the lightest, not being seen against the atmosphere; and this is seen in the leaves which are away from the centre of the tree, that is towards the light.

[Footnote: See Pl. XXVIII, No. 2, the lower sketch.]

434.

OF THE LIGHTS ON DARK LEAVES.

The lights on such leaves which are darkest, will be most near to the colour of the atmosphere that is reflected in them. And the cause of this is that the light on the illuminated portion mingles with the dark hue to compose a blue colour; and this light is produced by the blueness of the atmosphere which is reflected in the smooth surface of these leaves and adds to the blue hue which this light usually produces when it falls on dark objects.

OF THE LIGHTS ON LEAVES OF A YELLOWISH GREEN.

But leaves of a green verging on yellow when they reflect the atmosphere do not produce a reflection verging on blue, inasmuch as every thing which appears in a mirror takes some colour from that mirror, hence the blue of the atmosphere being reflected in the yellow of the leaf appears green, because blue and yellow mixed together make a very fine green colour, therefore the lustre of light leaves verging on yellow will be greenish yellow.

A classification of trees according to their colours.

435.

The trees in a landscape are of various kinds of green, inasmuch as some verge towards blackness, as firs, pines, cypresses, laurels, box and the like. Some tend to yellow such as walnuts, and pears, vines and verdure. Some are both yellowish and dark as chesnuts, holm-oak. Some turn red in autumn as the service-tree, pomegranate, vine, and cherry; and some are whitish as the willow, olive, reeds and the like. Trees are of various forms ...

The proportions of light and shade in trees (436-440).

436.

OF A GENERALLY DISTRIBUTED LIGHT AS LIGHTING UP TREES.

That part of the trees will be seen to lie in the least dark shadow which is farthest from the earth.

To prove it let $a p$ be the tree, $n b c$ the illuminated hemisphere [the sky], the under portion of the tree faces the earth $p c$, that is on the side o , and it faces a small part of the hemisphere at $c d$. But the highest part of the convexity a faces the greatest part of the hemisphere, that is $b c$. For this reason — and because it does not face the darkness of the earth — it is in fuller light. But if the tree has dense foliage, as the laurel, arbutus, box or holm oak, it will be different; because, although a does not face the earth, it faces the dark [green] of the leaves cut up by many shadows, and this darkness is reflected onto the under sides of the leaves immediately above. Thus these trees have their darkest shadows nearest to the middle of the tree.

437.

OF THE SHADOWS OF VERDURE.

The shadows of verdure are always somewhat blue, and so is every shadow of every object; and they assume this hue more in proportion as they are remote from the eye, and less in proportion as they are nearer. The leaves which reflect the blue of the atmosphere always present themselves to the eye edgewise.

OF THE ILLUMINATED PART OF VERDURE AND OF MOUNTAINS.

The illuminated portion, at a great distance, will appear most nearly of its natural colour where the strongest light falls upon it.

438.

OF TREES THAT ARE LIGHTED BY THE SUN AND BY THE ATMOSPHERE.

In trees that are illuminated [both] by the sun and the atmosphere and that have leaves of a dark colour, one side will be illuminated by the atmosphere [only] and in consequence of this light will tend to blueness, while on the other side they will be illuminated by the atmosphere and the sun; and the side which the eye sees illuminated by the sun will reflect light.

439.

OF DEPICTING A FOREST SCENE.

The trees and plants which are most thickly branched with slender branches ought to have less dark shadow than those trees and plants which, having broader leaves, will cast more shadow.

440.

ON PAINTING.

In the position of the eye which sees that portion of a tree illuminated which turns towards the light, one tree will never be seen to be illuminated equally with the other. To prove this, let the eye be *c* which sees the two trees *b d* which are illuminated by the sun *a*; I say that this eye *c* will not see the light in the same proportion to the shade, in one tree as in the other. Because, the tree which is nearest to the sun will display so much the stronger shadow than the more distant one, in proportion as one tree is nearer to the rays of the sun that converge to the eye than the other; &c.

You see that the eye *c* sees nothing of the tree *d* but shadow, while the same eye *c* sees the tree *b* half in light and half in shade.

When a tree is seen from below, the eye sees the top of it as placed within the circle made by its boughs.

Remember, O Painter! that the variety of depth of shade in any one particular

species of tree is in proportion to the rarity or density of their branches.

[Footnote: The two lower sketches on the left of Pl XXVIII, No. 3, refer to lines 21-23. The upper sketch has apparently been effaced by Leonardo himself.]

The distribution of light and shade with reference to the position of the spectator (441-443).

441.

The shadows of trees placed in a landscape do not display themselves in the same position in the trees on the right hand and those on the left; still more so if the sun is to the right or left. As is proved by the 4th which says: Opaque bodies placed between the light and the eye display themselves entirely in shadow; and by the 5th: The eye when placed between the opaque body and the light sees the opaque body entirely illuminated. And by the 6th: When the eye and the opaque body are placed between darkness and light, it will be seen half in shadow and half in light.

[Footnote: See the figure on the right hand side of Pl. XXVIII, No. 3. The first five lines of the text are written below the diagram and above it are the last eight lines of the text, given as No. 461.]

442.

OF THE HERBS OF THE FIELD.

Of the plants which take a shadow from the plants which spring among them, those which are on this side [in front] of the shadow have the stems lighted up on a background of shadow, and the plants on which the shadows fall have their stems dark on a light background; that is on the background beyond the shadow.

OF TREES WHICH ARE BETWEEN THE EYE AND THE LIGHT.

Of the trees which are between the eye and the light the part in front will be light; but this light will be broken by the ramifications of transparent leaves — being seen from the under side — and lustrous leaves — being seen from the

upper side; and the background below and behind will be dark green, being in shadow from the front portion of the said tree. This occurs in trees placed above the eye.

443.

FROM WHENCE TO DEPICT A LANDSCAPE

Landscapes should be represented so that the trees may be half in light and half in shadow; but it is better to do them when the sun is covered with clouds, for then the trees are lighted by the general light of the sky, and the general darkness of the earth. And then they are darkest in certain parts in proportion as those parts are nearest to the middle of the tree and to the earth.

The effects of morning light (444-448).

444.

OF TREES TO THE SOUTH.

When the sun is in the east the trees to the South and to the North have almost as much light as shadow. But a greater share of light in proportion as they lie to the West and a greater share of shadow in proportion as they lie to the East.

OF MEADOWS.

If the sun is in the East the verdure of the meadows and of other small plants is of a most beautiful green from being transparent to the sun; this does not occur in the meadows to the West, and in those to the South and North the grass is of a moderately brilliant green.

445.

OF THE 4 POINTS OF THE COMPASS [IN LANDSCAPES].

When the sun is in the East all the portions of plants lighted by it are of a most lively verdure, and this happens because the leaves lighted by the sun within the half of the horizon that is the Eastern half, are transparent; and within the Western semicircle the verdure is of a dull hue and the moist air is turbid and of the colour of grey ashes, not being transparent like that in the East, which is quite clear and all the more so in proportion as it is moister.

The shadows of the trees to the East cover a large portion of them and are darker in proportion as the foliage of the trees is thicker.

446.

OF TREES IN THE EAST.

When the sun is in the East the trees seen towards the East will have the light which surrounds them all round their shadows, excepting on the side towards the earth; unless the tree has been pruned [below] in the past year. And the trees to the South and North will be half in shade and half in light, and more or less in shade or in light in proportion as they are more or less to the East or to the West.

The [position of] the eye above or below varies the shadows and lights in trees, inasmuch as the eye placed above sees the tree with the little shadow, and the eye placed below with a great deal of shadow.

The colour of the green in plants varies as much as their species.

447.

OF THE SHADOWS IN TREES.

The sun being in the East [to the right], the trees to the West [or left] of the eye will show in small relief and almost imperceptible gradations, because the atmosphere which lies between the eye and those trees is very dense [Footnote 7:

per la 7a di questo. This possibly referred to something written on the seventh page of this note book marked *G*. Unfortunately it has been cut out and lost.], see the 7th of this — and they have no shade; for though a shadow exists in every detail of the ramification, it results that the images of the shade and light that reach the eye are confused and mingled together and cannot be perceived on account of their minuteness. And the principal lights are in the middle of the trees, and the shadows towards the edges; and their separation is shown by the shadows of the intervals between the trees; but when the forests are thick with trees the thin edges are but little seen.

448.

OF TREES TO THE EAST.

When the sun is in the East the trees are darker towards the middle while their edges are light.

The effects of midday light.

449.

OBJECTS IN HIGH LIGHT SHOW BUT LITTLE, BUT BETWEEN LIGHT AND SHADOW THEY STAND OUT WELL.

To represent a landscape choose that the sun shall be at noon and look towards the West or East and then draw. And if you turn towards the North, every object placed on that side will have no shadow, particularly those which are nearest to the [direction of the] shadow of your head. And if you turn towards the South every object on that side will be wholly in shadow. All the trees which are towards the sun and have the atmosphere for their background are dark, and the other trees which lie against that darkness will be black [very dark] in the middle and lighter towards the edges.

The appearance of trees in the distance (450. 451).

450.

OF THE SPACES [SHOWING THE SKY] IN TREES THEMSELVES.

The spaces between the parts in the mass of trees, and the spaces between the trees in the air, are, at great distances, invisible to the eye; for, where it is an effort [even] to see the whole it is most difficult to discern the parts. — But a confused mixture is the result, partaking chiefly of the [hue] which predominates. The spaces between the leaves consist of particles of illuminated air which are very much smaller than the tree and are lost sight of sooner than the tree; but it does not therefore follow that they are not there. Hence, necessarily, a compounded [effect] is produced of the sky and of the shadows of the tree in shade, which both together strike the eye which sees them.

OF TREES WHICH CONCEAL THESE SPACES IN ONE ANOTHER.

That part of a tree will show the fewest spaces, behind which a large number of trees are standing between the tree and the air [sky]; thus in the tree *a* the spaces are not concealed nor in *b*, as there is no tree behind. But in *c* only half shows the spaces filled up by the tree *d*, and part of the tree *d* is filled up by the tree *e* and a little farther on all the spaces in the mass of the trees are lost, and only that at the side remains.

451.

OF TREES.

What outlines are seen in trees at a distance against the sky which serves as their background?

The outlines of the ramification of trees, where they lie against the illuminated

sky, display a form which more nearly approaches the spherical on proportion as they are remote, and the nearer they are the less they appear in this spherical form; as in the first tree *a* which, being near to the eye, displays the true form of its ramification; but this shows less in *b* and is altogether lost in *c*, where not merely the branches of the tree cannot be seen but the whole tree is distinguished with difficulty. Every object in shadow, of whatever form it may be, at a great distance appears to be spherical. And this occurs because, if it is a square body, at a very short distance it loses its angles, and a little farther off it loses still more of its smaller sides which remain. And thus before the whole is lost [to sight] the parts are lost, being smaller than the whole; as a man, who in such a distant position loses his legs, arms and head before [the mass of] his body, then the outlines of length are lost before those of breadth, and where they have become equal it would be a square if the angles remained; but as they are lost it is round.

[Footnote: The sketch No. 4, Pl. XXVIII, belongs to this passage.]

The cast shadow of trees (452. 453).

452.

The image of the shadow of any object of uniform breadth can never be [exactly] the same as that of the body which casts it.

[Footnote: See Pl. XXVIII, No. 5.]

Light and shade on groups of trees (453-457).

453.

All trees seen against the sun are dark towards the middle and this shadow will be of the shape of the tree when apart from others.

The shadows cast by trees on which the sun shines are as dark as those of the middle of the tree.

The shadow cast by a tree is never less than the mass of the tree but becomes taller in proportion as the spot on which it falls, slopes towards the centre of the world.

The shadow will be densest in the middle of the tree when the tree has the fewest branches.

[Footnote: The three diagrams which accompany this text are placed, in the original, before lines 7-11. At the spots marked *B* Leonardo wrote *Albero* (tree). At *A* is the word *Sole* (sun), at *C Monte* (mountain) at *D piano* (plain) and at *E*

cima (summit).]

Every branch participates of the central shadow of every other branch and consequently [of that] of the whole tree.

The form of any shadow from a branch or tree is circumscribed by the light which falls from the side whence the light comes; and this illumination gives the shape of the shadow, and this may be of the distance of a mile from the side where the sun is.

If it happens that a cloud should anywhere overshadow some part of a hill the [shadow of the] trees there will change less than in the plains; for these trees on the hills have their branches thicker, because they grow less high each year than in the plains. Therefore as these branches are dark by nature and being so full of shade, the shadow of the clouds cannot darken them any more; but the open spaces between the trees, which have no strong shadow change very much in tone and particularly those which vary from green; that is ploughed lands or fallen mountains or barren lands or rocks. Where the trees are against the atmosphere they appear all the same colour — if indeed they are not very close together or very thickly covered with leaves like the fir and similar trees. When you see the trees from the side from which the sun lights them, you will see them almost all of the same tone, and the shadows in them will be hidden by the leaves in the light, which come between your eye and those shadows.

TREES AT A SHORT DISTANCE.

[Footnote 29: The heading *alberi vicini* (trees at a short distance) is in the original manuscript written in the margin.] When the trees are situated between the sun and the eye, beyond the shadow which spreads from their centre, the green of their leaves will be seen transparent; but this transparency will be broken in many places by the leaves and boughs in shadow which will come between you and them, or, in their upper portions, they will be accompanied by many lights reflected from the leaves.

454.

The trees of the landscape stand out but little from each other; because their illuminated portions come against the illuminated portions of those beyond and differ little from them in light and shade.

455.

Of trees seen from below and against the light, one beyond the other and near together. The topmost part of the first will be in great part transparent and light, and will stand out against the dark portion of the second tree. And thus it will be with all in succession that are placed under the same conditions.

Let *s* be the light, and *r* the eye, *c d n* the first tree, *a b c* the second. Then I say that *r*, the eye, will see the portion *c f* in great part transparent and lighted by the light *s* which falls upon it from the opposite side, and it will see it, on a dark ground *b c* because that is the dark part and shadow of the tree *a b c*.

But if the eye is placed at *t* it will see *o p* dark on the light background *n g*.

Of the transparent and shadowy parts of trees, that which is nearest to you is the darkest.

456.

That part of a tree which has shadow for background, is all of one tone, and wherever the trees or branches are thickest they will be darkest, because there are no little intervals of air. But where the boughs lie against a background of other boughs, the brighter parts are seen lightest and the leaves lustrous from the sunlight falling on them.

457.

In the composition of leafy trees be careful not to repeat too often the same colour of one tree against the same colour of another [behind it]; but vary it with a lighter, or a darker, or a stronger green.

On the treatment of light for landscapes (458-464).

458.

The landscape has a finer azure [tone] when, in fine weather the sun is at noon than at any other time of the day, because the air is purified of moisture; and looking at it under that aspect you will see the trees of a beautiful green at the outside and the shadows dark towards the middle; and in the remoter distance

the atmosphere which comes between you and them looks more beautiful when there is something dark beyond. And still the azure is most beautiful. The objects seen from the side on which the sun shines will not show you their shadows. But, if you are lower than the sun, you can see what is not seen by the sun and that will be all in shade. The leaves of the trees, which come between you and the sun are of two principal colours which are a splendid lustre of green, and the reflection of the atmosphere which lights up the objects which cannot be seen by the sun, and the shaded portions which only face the earth, and the darkest which are surrounded by something that is not dark. The trees in the landscape which are between you and the sun are far more beautiful than those you see when you are between the sun and them; and this is so because those which face the sun show their leaves as transparent towards the ends of their branches, and those that are not transparent — that is at the ends — reflect the light; and the shadows are dark because they are not concealed by any thing.

The trees, when you place yourself between them and the sun, will only display to you their light and natural colour, which, in itself, is not very strong, and besides this some reflected lights which, being against a background which does not differ very much from themselves in tone, are not conspicuous; and if you are lower down than they are situated, they may also show those portions on which the light of the sun does not fall and these will be dark.

In the Wind.

But, if you are on the side whence the wind blows, you will see the trees look very much lighter than on the other sides, and this happens because the wind turns up the under side of the leaves, which, in all trees, is much whiter than the upper sides; and, more especially, will they be very light indeed if the wind blows from the quarter where the sun is, and if you have your back turned to it.

[Footnote: At *S*, in the original is the word *Sole* (sun) and at *N parte di nuvolo* (the side of the clouds).]

459.

When the sun is covered by clouds, objects are less conspicuous, because there is little difference between the light and shade of the trees and of the buildings being illuminated by the brightness of the atmosphere which surrounds the objects in such a way that the shadows are few, and these few fade away so that their outline is lost in haze.

460.

OF TREES AND LIGHTS ON THEM.

The best method of practice in representing country scenes, or I should say landscapes with their trees, is to choose them so that the sun is covered with clouds so that the landscape receives an universal light and not the direct light of the sun, which makes the shadows sharp and too strongly different from the lights.

461.

OF PAINTING.

In landscapes which represent [a scene in] winter. The mountains should not be shown blue, as we see in the mountains in the summer. And this is proved [Footnote 5. 6.: *Per la* 4a di questo. It is impossible to ascertain what this quotation refers to. *Questo* certainly does not mean the MS. in hand, nor any other now known to us. The same remark applies to the phrase in line 15: *per la* 2a di questo.] in the 4th of this which says: Among mountains seen from a great distance those will look of the bluest colour which are in themselves the darkest; hence, when the trees are stripped of their leaves, they will show a bluer tinge which will be in itself darker; therefore, when the trees have lost their leaves they will look of a gray colour, while, with their leaves, they are green, and in proportion as the green is darker than the grey hue the green will be of a bluer tinge than the gray. Also by the 2nd of this: The shadows of trees covered with leaves are darker than the shadows of those trees which have lost their leaves in proportion as the trees covered with leaves are denser than those without leaves — and thus my meaning is proved.

The definition of the blue colour of the atmosphere explains why the landscape is bluer in the summer than in the winter.

462.

OF PAINTING IN A LANDSCAPE.

If the slope of a hill comes between the eye and the horizon, sloping towards the eye, while the eye is opposite the middle of the height of this slope, then that hill will increase in darkness throughout its length. This is proved by the 7th of this which says that a tree looks darkest when it is seen from below; the proposition is verified, since this hill will, on its upper half show all its trees as much from the side which is lighted by the light of the sky, as from that which is in shade from the darkness of the earth; whence it must result that these trees are of a medium darkness. And from this [middle] spot towards the base of the hill, these trees will be lighter by degrees by the converse of the 7th and by the said 7th: For trees so placed, the nearer they are to the summit of the hill the darker they necessarily become. But this darkness is not in proportion to the distance, by the 8th of this which says: That object shows darkest which is [seen] in the clearest atmosphere; and by the 10th: That shows darkest which stands out against a lighter background.

[Footnote: The quotation in this passage again cannot be verified.]

463.

OF LANDSCAPES.

The colours of the shadows in mountains at a great distance take a most lovely blue, much purer than their illuminated portions. And from this it follows that when the rock of a mountain is reddish the illuminated portions are violet (?) and the more they are lighted the more they display their proper colour.

464.

A place is most luminous when it is most remote from mountains.
On the treatment of light for views of towns (465-469).

465.

OF LIGHT AND SHADOW IN A TOWN.

When the sun is in the East and the eye is above the centre of a town, the eye will see the Southern part of the town with its roofs half in shade and half in light, and the same towards the North; the Eastern side will be all in shadow and the Western will be all in light.

466.

Of the houses of a town, in which the divisions between the houses may be distinguished by the light which fall on the mist at the bottom. If the eye is above the houses the light seen in the space that is between one house and the next sinks by degrees into thicker mist; and yet, being less transparent, it appears whiter; and if the houses are some higher than the others, since the true [colour] is always more discernible through the thinner atmosphere, the houses will look darker in proportion as they are higher up. Let $n o p q$ represent the various density of the atmosphere thick with moisture, a being the eye, the house $b c$ will look lightest at the bottom, because it is in a thicker atmosphere; the lines $c d f$ will appear equally light, for although f is more distant than c , it is raised into a thinner atmosphere, if the houses $b e$ are of the same height, because they cross a brightness which is varied by mist, but this is only because the line of the eye which starts from above ends by piercing a lower and denser atmosphere at d than at b . Thus the line $a f$ is lower at f than at c ; and the house f will be seen darker at e from the line $e k$ as far as m , than the tops of the houses standing in front of it.

467.

OF TOWNS OR OTHER BUILDINGS SEEN IN THE EVENING OR THE MORNING THROUGH

THE MIST.

Of buildings seen at a great distance in the evening or the morning, as in mist or dense atmosphere, only those portions are seen in brightness which are lighted up by the sun which is near the horizon; and those portions which are not lighted up by the sun remain almost of the same colour and medium tone as the mist.

WHY OBJECTS WHICH ARE HIGH UP AND AT A DISTANCE ARE DARKER THAN THE LOWER ONES, EVEN IF THE MIST IS UNIFORMLY DENSE.

Of objects standing in a mist or other dense atmosphere, whether from vapour or smoke or distance, those will be most visible which are the highest. And among objects of equal height that will be the darkest [strongest] which has for background the deepest mist. Thus the eye h looking at $a b c$, towers of equal height, one with another, sees c the top of the first tower at r , at two degrees of depth in the mist; and sees the height of the middle tower b through one single degree of mist. Therefore the top of the tower c appears stronger than the top of the tower b , &c.

468.

OF THE SMOKE OF A TOWN.

Smoke is seen better and more distinctly on the Eastern side than on the Western when the sun is in the East; and this arises from two causes; the first is that the sun, with its rays, shines through the particles of the smoke and lights them up and makes them visible. The second is that the roofs of the houses seen in the East at this time are in shadow, because their obliquity does not allow of their being illuminated by the sun. And the same thing occurs with dust; and both one

and the other look the lighter in proportion as they are denser, and they are densest towards the middle.

469.

OF SMOKE AND DUST.

If the sun is in the East the smoke of cities will not be visible in the West, because on that side it is not seen penetrated by the solar rays, nor on a dark background; since the roofs of the houses turn the same side to the eye as they turn towards the sun, and on this light background the smoke is not very visible.

But dust, under the same aspect, will look darker than smoke being of denser material than smoke which is moist.

The effect of wind on trees (470-473).

470.

OF REPRESENTING WIND.

In representing wind, besides the bending of the boughs and the reversing of their leaves towards the quarter whence the wind comes, you should also represent them amid clouds of fine dust mingled with the troubled air.

471.

Describe landscapes with the wind, and the water, and the setting and rising of the sun.

THE WIND.

All the leaves which hung towards the earth by the bending of the shoots with

their branches, are turned up side down by the gusts of wind, and here their perspective is reversed; for, if the tree is between you and the quarter of the wind, the leaves which are towards you remain in their natural aspect, while those on the opposite side which ought to have their points in a contrary direction have, by being turned over, their points turned towards you.

472.

Trees struck by the force of the wind bend to the side towards which the wind is blowing; and the wind being past they bend in the contrary direction, that is in reverse motion.

473.

That portion of a tree which is farthest from the force which strikes it is the most injured by the blow because it bears most strain; thus nature has foreseen this case by thickening them in that part where they can be most hurt; and most in such trees as grow to great heights, as pines and the like. [Footnote: Compare the sketch drawn with a pen and washed with Indian ink on Pl. XL, No. 1. In the Vatican copy we find, under a section entitled '*del fumo*', the following remark: Era sotto di questo capitolo un rompimento di montagna, per dentro delle quali rotture scherzaua fiamme di fuoco, disegnate di penna et ombrate d'acquarella, da uedere cosa mirabile et uiua (Ed. MANZI, p. 235. Ed. LUDWIG, Vol. I, 460). This appears to refer to the left hand portion of the drawing here given from the Windsor collection, and from this it must be inferred, that the leaf as it now exists in the library of the Queen of England, was already separated from the original MS. at the time when the Vatican copy was made.]

Light and shade on clouds (474-477).

474.

Describe how the clouds are formed and how they dissolve, and what cause raises vapour.

475.

The shadows in clouds are lighter in proportion as they are nearer to the horizon.

[Footnote: The drawing belonging to this was in black chalk and is totally effaced.]

476.

When clouds come between the sun and the eye all the upper edges of their round forms are light, and towards the middle they are dark, and this happens because towards the top these edges have the sun above them while you are below them; and the same thing happens with the position of the branches of trees; and again the clouds, like the trees, being somewhat transparent, are lighted up in part, and at the edges they show thinner.

But, when the eye is between the cloud and the sun, the cloud has the contrary effect to the former, for the edges of its mass are dark and it is light towards the middle; and this happens because you see the same side as faces the sun, and because the edges have some transparency and reveal to the eye that portion which is hidden beyond them, and which, as it does not catch the sunlight like that portion turned towards it, is necessarily somewhat darker. Again, it may be that you see the details of these rounded masses from the lower side, while the sun shines on the upper side and as they are not so situated as to reflect the light of the sun, as in the first instance they remain dark.

The black clouds which are often seen higher up than those which are illuminated by the sun are shaded by other clouds, lying between them and the sun.

Again, the rounded forms of the clouds that face the sun, show their edges dark because they lie against the light background; and to see that this is true, you may look at the top of any cloud that is wholly light because it lies against the blue of the atmosphere, which is darker than the cloud.

[Footnote: A drawing in red chalk from the Windsor collection (see Pl. XXIX), representing a landscape with storm-clouds, may serve to illustrate this section as well as the following one.]

477.

OF CLOUDS, SMOKE AND DUST AND THE FLAMES OF A FURNACE OR OF A BURNING KILN.

The clouds do not show their rounded forms excepting on the sides which face the sun; on the others the roundness is imperceptible because they are in the shade. [Footnote: The text of this chapter is given in facsimile on Pls. XXXVI and XXXVII. The two halves of the leaf form but one in the original. On the margin close to lines 4 and 5 is the note: *rossore d'aria inverso l'orizzonte* — (of the redness of the atmosphere near the horizon). The sketches on the lower portion of the page will be spoken of in No. 668.]

If the sun is in the East and the clouds in the West, the eye placed between the sun and the clouds sees the edges of the rounded forms composing these clouds as dark, and the portions which are surrounded by this dark [edge] are light. And this occurs because the edges of the rounded forms of these clouds are turned towards the upper or lateral sky, which is reflected in them.

Both the cloud and the tree display no roundness at all on their shaded side.

On images reflected in water.

478.

Painters often deceive themselves, by representing water in which they make the water reflect the objects seen by the man. But the water reflects the object from one side and the man sees it from the other; and it often happens that the painter sees an object from below, and thus one and the same object is seen from hind part before and upside down, because the water shows the image of the object in one way, and the eye sees it in another.

Of rainbows and rain (479. 480).

479.

The colours in the middle of the rainbow mingle together.

The bow in itself is not in the rain nor in the eye that sees it; though it is generated by the rain, the sun, and the eye. The rainbow is always seen by the eye that is between the rain and the body of the sun; hence if the sun is in the East and the rain is in the West it will appear on the rain in the West.

480.

When the air is condensed into rain it would produce a vacuum if the rest of the air did not prevent this by filling its place, as it does with a violent rush; and this is the wind which rises in the summer time, accompanied by heavy rain.

Of flower seeds.

481.

All the flowers which turn towards the sun perfect their seeds; but not the others; that is to say those which get only the reflection of the sun.

IX. THE PRACTICE OF PAINTING.

It is hardly necessary to offer any excuses for the division carried out in the arrangement of the text into practical suggestions and theoretical enquiries. It was evidently intended by Leonardo himself as we conclude from incidental remarks in the MSS. (for instance No 110). The fact that this arrangement was never carried out either in the old MS. copies or in any edition since, is easily accounted for by the general disorder which results from the provisional distribution of the various chapters in the old copies. We have every reason to believe that the earliest copyists, in distributing the materials collected by them, did not in the least consider the order in which the original MS. lay before them.

*It is evident that almost all the chapters which refer to the calling and life of the painter — and which are here brought together in the first section (Nos. 482-508) — may be referred to two distinct periods in Leonardo's life; most of them can be dated as belonging to the year 1492 or to 1515. At about this later time Leonardo may have formed the project of completing his *Libro della Pittura*, after an interval of some years, as it would seem, during which his interest in the subject had fallen somewhat into the background.*

*In the second section, which treats first of the artist's studio, the construction of a suitable window forms the object of careful investigations; the special importance attached to this by Leonardo is sufficiently obvious. His theory of the incidence of light which was fully discussed in a former part of this work, was to him by no means of mere abstract value, but, being deduced, as he says, from experience (or experiment) was required to prove its utility in practice. Connected with this we find suggestions for the choice of a light with practical hints as to sketching a picture and some other precepts of a practical character which must come under consideration in the course of completing the painting. In all this I have followed the same principle of arrangement in the text as was carried out in the *Theory of Painting*, thus the suggestions for the *Perspective of a picture*, (Nos. 536-569), are followed by the theory of light and shade for the practical method of optics (Nos. 548 — 566) and this by the practical precepts or the treatment of aerial perspective (567 — 570).*

*In the passage on *Portrait and Figure Painting* the principles of painting as applied to a bust and head are separated and placed first, since the advice to figure painters must have some connection with the principles of the treatment of*

composition by which they are followed.

But this arrangement of the text made it seem advisable not to pick out the practical precepts as to the representation of trees and landscape from the close connection in which they were originally placed — unlike the rest of the practical precepts — with the theory of this branch of the subject. They must therefore be sought under the section entitled Botany for Painters.

As a supplement to the Libro di Pittura I have here added those texts which treat of the Painter's materials, — as chalk, drawing paper, colours and their preparation, of the management of oils and varnishes; in the appendix are some notes on chemical substances. Possibly some of these, if not all, may have stood in connection with the preparation of colours. It is in the very nature of things that Leonardo's incidental indications as to colours and the like should be now-a-days extremely obscure and could only be explained by professional experts — by them even in but few instances. It might therefore have seemed advisable to reproduce exactly the original text without offering any translation. The rendering here given is merely an attempt to suggest what Leonardo's meaning may have been.

LOMAZZO tells us in his Trattato dell'arte della Pittura, Scultura ed Architettura (Milano 1584, libro II, Cap. XIV): “Va scorrendo ed argomentando Leonardo Vinci in un suo libro letto da me (?) questi anni passati, ch'egli scrisse di mano stanca ai prieghi di LUDOVICO SFORZA duca di Milano, in determinazione di questa questione, se e piu nobile la pittura o la scultura; dicendo che quanto piu un'arte porta seco fatica di corpo, e sudore, tanto piu e vile, e men pregiata”. But the existence of any book specially written for Lodovico il Moro on the superiority of Painting over sculpture is perhaps mythical. The various passages in praise of Painting as compared not merely with Sculpture but with Poetry, are scattered among MSS. of very different dates.

Besides, the way, in which the subject is discussed appears not to support the supposition, that these texts were prepared at a special request of the Duke.

I.

MORAL PRECEPTS FOR THE STUDENT OF PAINTING.

How to ascertain the dispositions for an artistic career.

A WARNING CONCERNING YOUTHS WISHING TO BE PAINTERS.

Many are they who have a taste and love for drawing, but no talent; and this will be discernible in boys who are not diligent and never finish their drawings with shading.

The course of instruction for an artist (483-485).

483.

The youth should first learn perspective, then the proportions of objects. Then he may copy from some good master, to accustom himself to fine forms. Then from nature, to confirm by practice the rules he has learnt. Then see for a time the works of various masters. Then get the habit of putting his art into practice and work.

[Footnote: The Vatican copy and numerous abridgements all place this chapter at the beginning of the *Trattato*, and in consequence DUFRESNE and all subsequent editors have done the same. In the Vatican copy however all the general considerations on the relation of painting to the other arts are placed first, as introductory.]

484.

OF THE ORDER OF LEARNING TO DRAW.

First draw from drawings by good masters done from works of art and from nature, and not from memory; then from plastic work, with the guidance of the drawing done from it; and then from good natural models and this you must put into practice.

485.

PRECEPTS FOR DRAWING.

The artist ought first to exercise his hand by copying drawings from the hand of a good master. And having acquired that practice, under the criticism of his master, he should next practise drawing objects in relief of a good style, following the rules which will presently be given.

The study of the antique (486. 487).

486.

OF DRAWING.

Which is best, to draw from nature or from the antique? and which is more difficult to do outlines or light and shade?

487.

It is better to imitate [copy] the antique than modern work.

[Footnote 486, 487: These are the only two passages in which Leonardo alludes to the importance of antique art in the training of an artist. The question asked in No. 486 remains unanswered by him and it seems to me very doubtful whether the opinion stated in No. 487 is to be regarded as a reply to it. This opinion stands in the MS. in a connection — as will be explained later on — which seems to require us to limit its application to a single special case. At any rate we may suspect that when Leonardo put the question, he felt some hesitation as to the answer. Among his very numerous drawings I have not been able to find a single study from the antique, though a drawing in black chalk, at Windsor, of a man on horseback (Pl. LXXIII) may perhaps be a reminiscence of the statue of Marcus Aurelius at Rome. It seems to me that the drapery in a pen and ink drawing of a bust, also at Windsor, has been borrowed from an antique model (Pl. XXX). G. G. Rossi has, I believe, correctly interpreted Leonardo's feeling towards the antique in the following note on this passage in manzi's edition, p. 501: "Sappiamo dalla storia, che i valorosi artisti Toscani dell'età dell'oro dell'arte studiarono sugli antichi marmi raccolti dal Magnifico LORENZO DE' MEDICI. Pare che il Vinci a tali monumenti non si accostasse. Quest' uomo sempre riconosce per maestra la natura, e questo principio lo stringeva alla sola imitazione di essa" — Compare No. 10, 26 — 28 footnote.]

The necessity of anatomical knowledge (488. 489).

488.

OF PAINTING.

It is indispensable to a Painter who would be thoroughly familiar with the limbs in all the positions and actions of which they are capable, in the nude, to know the anatomy of the sinews, bones, muscles and tendons so that, in their various movements and exertions, he may know which nerve or muscle is the cause of

each movement and show those only as prominent and thickened, and not the others all over [the limb], as many do who, to seem great draughtsmen, draw their nude figures looking like wood, devoid of grace; so that you would think you were looking at a sack of walnuts rather than the human form, or a bundle of radishes rather than the muscles of figures.

489.

HOW IT IS NECESSARY TO A PAINTER THAT HE SHOULD KNOW THE INTRINSIC FORMS [STRUCTURE] OF MAN.

The painter who is familiar with the nature of the sinews, muscles, and tendons, will know very well, in giving movement to a limb, how many and which sinews cause it; and which muscle, by swelling, causes the contraction of that sinew; and which sinews, expanded into the thinnest cartilage, surround and support the said muscle. Thus he will variously and constantly demonstrate the different muscles by means of the various attitudes of his figures, and will not do, as many who, in a variety of movements, still display the very same things [modelling] in the arms, back, breast and legs. And these things are not to be regarded as minor faults.

How to acquire practice.

490.

OF STUDY AND THE ORDER OF STUDY.

I say that first you ought to learn the limbs and their mechanism, and having this knowledge, their actions should come next, according to the circumstances in which they occur in man. And thirdly to compose subjects, the studies for which should be taken from natural actions and made from time to time, as circumstances allow; and pay attention to them in the streets and *piazze* and fields, and note them down with a brief indication of the forms; [Footnote 5: Lines 5-7 explained by the lower portion of the sketch No. 1 on Pl. XXXI.] thus for a head make an o, and for an arm a straight or a bent line, and the same for the legs and the body, [Footnote 7: Lines 5-7 explained by the lower portion of the sketch No. 1 on Pl. XXXI.] and when you return home work out these notes

in a complete form. The Adversary says that to acquire practice and do a great deal of work it is better that the first period of study should be employed in drawing various compositions done on paper or on walls by divers masters, and that in this way practice is rapidly gained, and good methods; to which I reply that the method will be good, if it is based on works of good composition and by skilled masters. But since such masters are so rare that there are but few of them to be found, it is a surer way to go to natural objects, than to those which are imitated from nature with great deterioration, and so form bad methods; for he who can go to the fountain does not go to the water-jar.

[Footnote: This passage has been published by Dr. M. JORDAN, *Das Malerbuck des L. da Vinci*, p. 89; his reading however varies slightly from mine.]

Industry and thoroughness the first conditions (491-493.)

491.

WHAT RULES SHOULD BE GIVEN TO BOYS LEARNING TO PAINT.

We know for certain that sight is one of the most rapid actions we can perform. In an instant we see an infinite number of forms, still we only take in thoroughly one object at a time. Supposing that you, Reader, were to glance rapidly at the whole of this written page, you would instantly perceive that it was covered with various letters; but you could not, in the time, recognise what the letters were, nor what they were meant to tell. Hence you would need to see them word by word, line by line to be able to understand the letters. Again, if you wish to go to the top of a building you must go up step by step; otherwise it will be impossible that you should reach the top. Thus I say to you, whom nature prompts to pursue this art, if you wish to have a sound knowledge of the forms of objects begin with the details of them, and do not go on to the second [step] till you have the first well fixed in memory and in practice. And if you do otherwise you will throw away your time, or certainly greatly prolong your studies. And remember to acquire diligence rather than rapidity.

492.

HOW THAT DILIGENCE [ACCURACY] SHOULD FIRST BE LEARNT RATHER THAN RAPID

EXECUTION.

If you, who draw, desire to study well and to good purpose, always go slowly to work in your drawing; and discriminate in the lights, which have the highest degree of brightness, and to what extent and likewise in the shadows, which are those that are darker than the others and in what way they intermingle; then their masses and the relative proportions of one to the other. And note in their outlines, which way they tend; and which part of the lines is curved to one side or the other, and where they are more or less conspicuous and consequently broad or fine; and finally, that your light and shade blend without strokes and borders [but] looking like smoke. And when you have thus schooled your hand and your judgment by such diligence, you will acquire rapidity before you are aware.

The artist's private life and choice of company (493-494).

493.

OF THE LIFE OF THE PAINTER IN THE COUNTRY.

A painter needs such mathematics as belong to painting. And the absence of all companions who are alienated from his studies; his brain must be easily impressed by the variety of objects, which successively come before him, and also free from other cares [Footnote 6: Leonardo here seems to be speaking of his own method of work as displayed in his MSS. and this passage explains, at least in part, the peculiarities in their arrangement.]. And if, when considering and defining one subject, a second subject intervenes — as happens when an object occupies the mind, then he must decide which of these cases is the more difficult to work out, and follow that up until it becomes quite clear, and then work out the explanation of the other [Footnote 11: Leonardo here seems to be speaking of his own method of work as displayed in his MSS. and this passage explains, at least in part, the peculiarities in their arrangement.]. And above all he must keep his mind as clear as the surface of a mirror, which assumes colours as various as those of the different objects. And his companions should be like him as to their studies, and if such cannot be found he should keep his speculations to himself alone, so that at last he will find no more useful company [than his own].

[Footnote: In the title line Leonardo had originally written *del pictore filosofo* (the philosophical painter), but he himself struck out *filosofo*. Compare in No. 363 *pictora notomista* (anatomical painter). The original text is partly

OF THE LIFE OF THE PAINTER IN HIS STUDIO.

To the end that well-being of the body may not injure that of the mind, the painter or draughtsman must remain solitary, and particularly when intent on those studies and reflections which will constantly rise up before his eye, giving materials to be well stored in the memory. While you are alone you are entirely your own [master] and if you have one companion you are but half your own, and the less so in proportion to the indiscretion of his behaviour. And if you have many companions you will fall deeper into the same trouble. If you should say: "I will go my own way and withdraw apart, the better to study the forms of natural objects", I tell you, you will not be able to help often listening to their chatter. And so, since one cannot serve two masters, you will badly fill the part of a companion, and carry out your studies of art even worse. And if you say: "I will withdraw so far that their words cannot reach me and they cannot disturb me", I can tell you that you will be thought mad. But, you see, you will at any rate be alone. And if you must have companions ship find it in your studio. This may assist you to have the advantages which arise from various speculations. All other company may be highly mischievous.

The distribution of time for studying (495-497).

OF WHETHER IT IS BETTER TO DRAW WITH COMPANIONS OR NOT.

I say and insist that drawing in company is much better than alone, for many reasons. The first is that you would be ashamed to be seen behindhand among the students, and such shame will lead you to careful study. Secondly, a wholesome emulation will stimulate you to be among those who are more praised than yourself, and this praise of others will spur you on. Another is that you can learn from the drawings of others who do better than yourself; and if you are better than they, you can profit by your contempt for their defects, while the praise of others will incite you to farther merits.

[Footnote: The contradiction by this passage of the foregoing chapter is only apparent. It is quite clear, from the nature of the reasoning which is here used to

prove that it is more improving to work with others than to work alone, that the studies of pupils only are under consideration here.]

496.

OF STUDYING, IN THE DARK, WHEN YOU WAKE, OR IN BED BEFORE YOU GO TO SLEEP.

I myself have proved it to be of no small use, when in bed in the dark, to recall in fancy the external details of forms previously studied, or other noteworthy things conceived by subtle speculation; and this is certainly an admirable exercise, and useful for impressing things on the memory.

497.

OF THE TIME FOR STUDYING SELECTION OF SUBJECTS.

Winter evenings ought to be employed by young students in looking over the things prepared during the summer; that is, all the drawings from the nude done in the summer should be brought together and a choice made of the best [studies of] limbs and bodies among them, to apply in practice and commit to memory.

OF POSITIONS.

After this in the following summer you should select some one who is well grown and who has not been brought up in doublets, and so may not be of stiff carriage, and make him go through a number of agile and graceful actions; and if his muscles do not show plainly within the outlines of his limbs that does not matter at all. It is enough that you can see good attitudes and you can correct [the drawing of] the limbs by those you studied in the winter.

[Footnote: An injunction to study in the evening occurs also in No. 524.]

On the productive power of minor artists (498-501).

498.

He is a poor disciple who does not excel his master.

499.

Nor is the painter praiseworthy who does but one thing well, as the nude figure, heads, draperies, animals, landscapes or other such details, irrespective of other work; for there can be no mind so inept, that after devoting itself to one single thing and doing it constantly, it should fail to do it well.

[Footnote: In MANZI'S edition (p. 502) the painter G. G. Bossi indignantly remarks on this passage. "*Parla il Vince in questo luogo come se tutti gli artisti avessero quella sublimità d'ingegno capace di abbracciare tutte le cose, di cui era egli dotato*" And he then mentions the case of CLAUDE LORRAIN. But he overlooks the fact that in Leonardo's time landscape painting made no pretensions to independence but was reckoned among the details (*particolari*, lines 3, 4).]

500.

THAT A PAINTER IS NOT ADMIRABLE UNLESS HE IS UNIVERSAL.

Some may distinctly assert that those persons are under a delusion who call that painter a good master who can do nothing well but a head or a figure. Certainly this is no great achievement; after studying one single thing for a life-time who would not have attained some perfection in it? But, since we know that painting embraces and includes in itself every object produced by nature or resulting from the fortuitous actions of men, in short, all that the eye can see, he seems to me but a poor master who can only do a figure well. For do you not perceive how many and various actions are performed by men only; how many different animals there are, as well as trees, plants, flowers, with many mountainous regions and plains, springs and rivers, cities with public and private buildings, machines, too, fit for the purposes of men, divers costumes, decorations and arts? And all these things ought to be regarded as of equal importance and value, by the man who can be termed a good painter.

501.

OF THE MISERABLE PRETENCES MADE BY THOSE WHO FALSELY AND UNWORTHILY ACQUIRE THE NAME OF PAINTERS.

Now there is a certain race of painters who, having studied but little, must need take as their standard of beauty mere gold and azure, and these, with supreme conceit, declare that they will not give good work for miserable payment, and that they could do as well as any other if they were well paid. But, ye foolish folks! cannot such artists keep some good work, and then say: this is a costly work and this more moderate and this is average work and show that they can work at all prices?

A caution against one-sided study.

502.

HOW, IN IMPORTANT WORKS, A MAN SHOULD NOT TRUST ENTIRELY TO HIS MEMORY WITHOUT CONDESCENDING TO DRAW FROM NATURE.

Any master who should venture to boast that he could remember all the forms and effects of nature would certainly appear to me to be graced with extreme ignorance, inasmuch as these effects are infinite and our memory is not extensive enough to retain them. Hence, O! painter, beware lest the lust of gain should supplant in you the dignity of art; for the acquisition of glory is a much greater thing than the glory of riches. Hence, for these and other reasons which might be given, first strive in drawing to represent your intention to the eye by expressive forms, and the idea originally formed in your imagination; then go on taking out or putting in, until you have satisfied yourself. Then have living men, draped or nude, as you may have purposed in your work, and take care that in dimensions and size, as determined by perspective, nothing is left in the work which is not in harmony with reason and the effects in nature. And this will be the way to win honour in your art.

How to acquire universality (503-506).

503.

OF VARIETY IN THE FIGURES.

The painter should aim at universality, because there is a great want of self-

respect in doing one thing well and another badly, as many do who study only the [rules of] measure and proportion in the nude figure and do not seek after variety; for a man may be well proportioned, or he may be fat and short, or tall and thin, or medium. And a painter who takes no account of these varieties always makes his figures on one pattern so that they might all be taken for brothers; and this is a defect that demands stern reprehension.

504.

HOW SOMETHING MAY BE LEARNT EVERYWHERE.

Nature has beneficently provided that throughout the world you may find something to imitate.

505.

OF THE MEANS OF ACQUIRING UNIVERSALITY.

It is an easy matter to men to acquire universality, for all terrestrial animals resemble each other as to their limbs, that is in their muscles, sinews and bones; and they do not vary excepting in length or in thickness, as will be shown under Anatomy. But then there are aquatic animals which are of great variety; I will not try to convince the painter that there is any rule for them for they are of infinite variety, and so is the insect tribe.

506.

PAINTING.

The mind of the painter must resemble a mirror, which always takes the colour of the object it reflects and is completely occupied by the images of as many objects as are in front of it. Therefore you must know, Oh Painter! that you cannot be a good one if you are not the universal master of representing by your art every kind of form produced by nature. And this you will not know how to do if you do not see them, and retain them in your mind. Hence as you go through the fields, turn your attention to various objects, and, in turn look now at this thing and now at that, collecting a store of divers facts selected and chosen from those of less value. But do not do like some painters who, when they are wearied with exercising their fancy dismiss their work from their thoughts and

take exercise in walking for relaxation, but still keep fatigue in their mind which, though they see various objects [around them], does not apprehend them; but, even when they meet friends or relations and are saluted by them, although they see and hear them, take no more cognisance of them than if they had met so much empty air.

Useful games and exercises (507. 508).

507.

OF GAMES TO BE PLAYED BY THOSE WHO DRAW.

When, Oh draughtsmen, you desire to find relaxation in games you should always practise such things as may be of use in your profession, by giving your eye good practice in judging accurately of the breadth and length of objects. Thus, to accustom your mind to such things, let one of you draw a straight line at random on a wall, and each of you, taking a blade of grass or of straw in his hand, try to cut it to the length that the line drawn appears to him to be, standing at a distance of 10 braccia; then each one may go up to the line to measure the length he has judged it to be. And he who has come nearest with his measure to the length of the pattern is the best man, and the winner, and shall receive the prize you have settled beforehand. Again you should take forshortened measures: that is take a spear, or any other cane or reed, and fix on a point at a certain distance; and let each one estimate how many times he judges that its length will go into that distance. Again, who will draw best a line one braccio long, which shall be tested by a thread. And such games give occasion to good practice for the eye, which is of the first importance in painting.

508.

A WAY OF DEVELOPING AND AROUSING THE MIND TO VARIOUS INVENTIONS.

I cannot forbear to mention among these precepts a new device for study which, although it may seem but trivial and almost ludicrous, is nevertheless extremely useful in arousing the mind to various inventions. And this is, when you look at a wall spotted with stains, or with a mixture of stones, if you have to devise some scene, you may discover a resemblance to various landscapes, beautified with mountains, rivers, rocks, trees, plains, wide valleys and hills in varied arrangement; or again you may see battles and figures in action; or strange faces

and costumes, and an endless variety of objects, which you could reduce to complete and well drawn forms. And these appear on such walls confusedly, like the sound of bells in whose jangle you may find any name or word you choose to imagine.

II.

THE ARTIST'S STUDIO. — INSTRUMENTS AND HELPS FOR THE APPLICATION OF PERSPECTIVE. — ON JUDGING OF A PICTURE.

On the size of the studio.

509.

Small rooms or dwellings discipline the mind, large ones weaken it.
On the construction of windows (510-512).

510.

The larger the wall the less the light will be.

511.

The different kinds of light afforded in cellars by various forms of windows. The least useful and the coldest is the window at *a*. The most useful, the lightest and warmest and most open to the sky is the window at *b*. The window at *c* is of medium utility.

[Footnote: From a reference to the notes on the right light for painting it becomes evident that the observations made on cellar-windows have a direct bearing on the construction of the studio-window. In the diagram *b* as well as in that under No. 510 the window-opening is reduced to a minimum, but only, it would seem, in order to emphasize the advantage of walls constructed on the plan there shown.]

512.

OF THE PAINTER'S WINDOW AND ITS ADVANTAGE.

The painter who works from nature should have a window, which he can raise and lower. The reason is that sometimes you will want to finish a thing you are drawing, close to the light.

Let *a b c d* be the chest on which the work may be raised or lowered, so that the work moves up and down and not the painter. And every evening you can let down the work and shut it up above so that in the evening it may be in the fashion of a chest which, when shut up, may serve the purpose of a bench.

[Footnote: See Pl. XXXI, No. 2. In this plate the lines have unfortunately lost their sharpness, for the accidental loss of the negative has necessitated a reproduction from a positive. But having formerly published this sketch by another process, in VON LUTZOW'S *Zeitschrift für bildende Kunst* (Vol. XVII, pg. 13) I have reproduced it here in the text. The sharpness of the outline in the original sketch is here preserved but it gives it from the reversed side.]

On the best light for painting (513-520).

513.

Which light is best for drawing from nature; whether high or low, or large or small, or strong and broad, or strong and small, or broad and weak or small and weak?

[Footnote: The question here put is unanswered in the original MS.]

514.

OF THE QUALITY OF THE LIGHT.

A broad light high up and not too strong will render the details of objects very agreeable.

515.

THAT THE LIGHT FOR DRAWING FROM NATURE SHOULD BE HIGH UP.

The light for drawing from nature should come from the North in order that it

may not vary. And if you have it from the South, keep the window screened with cloth, so that with the sun shining the whole day the light may not vary. The height of the light should be so arranged as that every object shall cast a shadow on the ground of the same length as itself.

516.

THE KIND OF LIGHT REQUISITE FOR PAINTING LIGHT AND SHADE.

An object will display the greatest difference of light and shade when it is seen in the strongest light, as by sunlight, or, at night, by the light of a fire. But this should not be much used in painting because the works remain crude and ungraceful.

An object seen in a moderate light displays little difference in the light and shade; and this is the case towards evening or when the day is cloudy, and works then painted are tender and every kind of face becomes graceful. Thus, in every thing extremes are to be avoided: Too much light gives crudeness; too little prevents our seeing. The medium is best.

OF SMALL LIGHTS.

Again, lights cast from a small window give strong differences of light and shade, all the more if the room lighted by it be large, and this is not good for painting.

517.

PAINTING.

The luminous air which enters by passing through orifices in walls into dark rooms will render the place less dark in proportion as the opening cuts into the walls which surround and cover in the pavement.

518.

OF THE QUALITY OF LIGHT.

In proportion to the number of times that *a b* goes into *c d* will it be more luminous than *c d*. And similarly, in proportion as the point *e* goes into *c d* will it be more luminous than *c d*; and this light is useful for carvers of delicate work. [Footnote 5: For the same reason a window thus constructed would be convenient for an illuminator or a miniature painter.]

[Footnote: M. RAVAISSON in his edition of the Paris MS. A remarks on this passage: "*La figure porte les lettres f et g, auxquelles rien ne renvoie dans l'explication; par consequent, cette explication est incomplete. La figure semblerait, d'ailleurs, se rapporter a l'effet de la reflexion par un miroir concave.*" So far as I can see the text is not imperfect, nor is the sense obscure. It is hardly necessary to observe that *c d* here indicate the wall of the room opposite to the window *e* and the semicircle described by *f g* stands for the arch of the sky; this occurs in various diagrams, for example under 511. A similar semicircle, Pl III, No. 2 (and compare No. 149) is expressly called '*orizonte*' in writing.]

519.

That the light should fall upon a picture from one window only. This may be seen in the case of objects in this form. If you want to represent a round ball at a certain height you must make it oval in this shape, and stand so far off as that by foreshortening it appears round.

520.

OF SELECTING THE LIGHT WHICH GIVES MOST GRACE TO FACES.

If you should have a court yard that you can at pleasure cover with a linen awning that light will be good. Or when you want to take a portrait do it in dull weather, or as evening falls, making the sitter stand with his back to one of the walls of the court yard. Note in the streets, as evening falls, the faces of the men and women, and when the weather is dull, what softness and delicacy you may perceive in them. Hence, Oh Painter! have a court arranged with the walls tinted black and a narrow roof projecting within the walls. It should be 10 braccia wide and 20 braccia long and 10 braccia high and covered with a linen awning; or else paint a work towards evening or when it is cloudy or misty, and this is a perfect light.

On various helps in preparing a picture (521-530).

521.

To draw a nude figure from nature, or any thing else, hold in your hand a plumb-line to enable you to judge of the relative position of objects.

522.

OF DRAWING AN OBJECT.

When you draw take care to set up a principal line which you must observe all throughout the object you are drawing; every thing should bear relation to the direction of this principal line.

523.

OF A MODE OF DRAWING A PLACE ACCURATELY.

Have a piece of glass as large as a half sheet of royal folio paper and set thus firmly in front of your eyes that is, between your eye and the thing you want to draw; then place yourself at a distance of $\frac{2}{3}$ of a braccia from the glass fixing your head with a machine in such a way that you cannot move it at all. Then shut or entirely cover one eye and with a brush or red chalk draw upon the glass that which you see beyond it; then trace it on paper from the glass, afterwards transfer it onto good paper, and paint it if you like, carefully attending to the arial perspective.

HOW TO LEARN TO PLACE YOUR FIGURES CORRECTLY.

If you want to acquire a practice of good and correct attitudes for your figures, make a square frame or net, and square it out with thread; place this between your eye and the nude model you are drawing, and draw these same squares on the paper on which you mean to draw the figure, but very delicately. Then place a pellet of wax on a spot of the net which will serve as a fixed point, which, whenever you look at your model, must cover the pit of the throat; or, if his back is turned, it may cover one of the vertebrae of the neck. Thus these threads will

guide you as to each part of the body which, in any given attitude will be found below the pit of the throat, or the angles of the shoulders, or the nipples, or hips and other parts of the body; and the transverse lines of the net will show you how much the figure is higher over the leg on which it is posed than over the other, and the same with the hips, and the knees and the feet. But always fix the net perpendicularly so that all the divisions that you see the model divided into by the net work correspond with your drawing of the model on the net work you have sketched. The squares you draw may be as much smaller than those of the net as you wish that your figure should be smaller than nature. Afterwards remember when drawing figures, to use the rule of the corresponding proportions of the limbs as you have learnt it from the frame and net. This should be 3 braccia and a half high and 3 braccia wide; 7 braccia distant from you and 1 braccio from the model.

[Footnote: Leonardo is commonly credited with the invention of the arrangement of a plate of glass commonly known as the “vertical plane.” Professor E. VON BRUCKE in his *“Bruchstücke aus der Theorie der bildenden Künste,”* Leipzig 1877, pg. 3, writes on this contrivance. *“Unsere Glastafel ist die sogenannte Glastafel des Leonardo da Vinci, die in Gestalt einer Glastafel vorgestellte Bildfläche.”*]

524.

A METHOD OF DRAWING AN OBJECT IN RELIEF AT NIGHT.

Place a sheet of not too transparent paper between the rilievo and the light and you can draw thus very well.

[Footnote: Bodies thus illuminated will show on the surface of the paper how the copyist has to distribute light and shade.]

525.

If you want to represent a figure on a wall, the wall being foreshortened, while the figure is to appear in its proper form, and as standing free from the wall, you must proceed thus: have a thin plate of iron and make a small hole in the centre; this hole must be round. Set a light close to it in such a position as that it shines through the central hole, then place any object or figure you please so close to the wall that it touches it and draw the outline of the shadow on the wall; then fill in the shade and add the lights; place the person who is to see it so that he

looks through that same hole where at first the light was; and you will never be able to persuade yourself that the image is not detached from the wall.

[Footnote: *uno piccolo spiracelo nel mezzo*. M. RAVAISSON, in his edition of MS. A (Paris), p. 52, reads *nel muro* — evidently a mistake for *nel mezzo* which is quite plainly written; and he translates it “*fait lui une petite ouverture dans le mur*,” adding in a note: “*les mots ‘dans le mur’ paraissent etre de trop. Leonardo a du les ecrire par distraction*” But ‘*nel mezzo*’ is clearly legible even on the photograph facsimile given by Ravaisson himself, and the objection he raises disappears at once. It is not always wise or safe to try to prove our author’s absence of mind or inadvertence by apparent difficulties in the sense or connection of the text.]

526.

TO DRAW A FIGURE ON A WALL 12 BRACCIA HIGH WHICH SHALL LOOK 24 BRACCIA HIGH.

If you wish to draw a figure or any other object to look 24 braccia high you must do it in this way. First, on the surface *m r* draw half the man you wish to represent; then the other half; then put on the vault *m n* [the rest of] the figure spoken of above; first set out the vertical plane on the floor of a room of the same shape as the wall with the coved part on which you are to paint your figure. Then, behind it, draw a figure set out in profile of whatever size you please, and draw lines from it to the point *f* and, as these lines cut *m n* on the vertical plane, so will the figure come on the wall, of which the vertical plane gives a likeness, and you will have all the [relative] heights and prominences of the figure. And the breadth or thickness which are on the upright wall *m n* are to be drawn in their proper form, since, as the wall recedes the figure will be foreshortened by itself; but [that part of] the figure which goes into the cove you must foreshorten, as if it were standing upright; this diminution you must set out on a flat floor and there must stand the figure which is to be transferred from the vertical plane *r n* [Footnote 17: *che leverai dalla pariete r n*. The letters refer to the larger sketch, No. 3 on Pl. XXXI.] in its real size and reduce it once more on a vertical plane; and this will be a good method [Footnote 18: Leonardo here says nothing as to how the image foreshortened by perspective and thus produced on the vertical plane is to be transferred to the wall; but from what is said in Nos. 525 and 523 we may conclude that he was familiar with the process of casting the enlarged shadow of a squaring net on the surface of a wall to guide him in drawing the

figure.

Pariete di rilieuo; “sur une parai en relief” (RAVAISSON). “*Auf einer Schnittlinie zum Aufrichten*” (LUDWIG). The explanation of this puzzling expression must be sought in No. 545, lines 15-17.].

[Footnote: See Pl. XXXI. 3. The second sketch, which in the plate is incomplete, is here reproduced and completed from the original to illustrate the text. In the original the larger diagram is placed between lines 5 and 6.

1. 2. C. A. 157a; 463a has the similar heading: ‘*del cressciare della figura*’, and the text begins: “*Se voli fare 1a figura grande b c*” but here it breaks off. The translation here given renders the meaning of the passage as I think it must be understood. The MS. is perfectly legible and the construction of the sentence is simple and clear; difficulties can only arise from the very fullness of the meaning, particularly towards the end of the passage.]

527.

If you would to draw a cube in an angle of a wall, first draw the object in its own proper shape and raise it onto a vertical plane until it resembles the angle in which the said object is to be represented.

528.

Why are paintings seen more correctly in a mirror than out of it?

529.

HOW THE MIRROR IS THE MASTER [AND GUIDE] OF PAINTERS.

When you want to see if your picture corresponds throughout with the objects you have drawn from nature, take a mirror and look in that at the reflection of the real things, and compare the reflected image with your picture, and consider whether the subject of the two images duly corresponds in both, particularly studying the mirror. You should take the mirror for your guide — that is to say a flat mirror — because on its surface the objects appear in many respects as in a painting. Thus you see, in a painting done on a flat surface, objects which appear in relief, and in the mirror — also a flat surface — they look the same. The picture has one plane surface and the same with the mirror. The picture is

intangible, in so far as that which appears round and prominent cannot be grasped in the hands; and it is the same with the mirror. And since you can see that the mirror, by means of outlines, shadows and lights, makes objects appear in relief, you, who have in your colours far stronger lights and shades than those in the mirror, can certainly, if you compose your picture well, make that also look like a natural scene reflected in a large mirror.

[Footnote: I understand the concluding lines of this passage as follows: If you draw the upper half a figure on a large sheet of paper laid out on the floor of a room (*sala be piana*) to the same scale (*con le sue vere grosseze*) as the lower half, already drawn upon the wall (lines 10, 11) you must then reduce them on a '*pariete di rilievo*,' a curved vertical plane which serves as a model to reproduce the form of the vault.]

530.

OF JUDGING YOUR OWN PICTURES.

We know very well that errors are better recognised in the works of others than in our own; and that often, while reproving little faults in others, you may ignore great ones in yourself. To avoid such ignorance, in the first place make yourself a master of perspective, then acquire perfect knowledge of the proportions of men and other animals, and also, study good architecture, that is so far as concerns the forms of buildings and other objects which are on the face of the earth; these forms are infinite, and the better you know them the more admirable will your work be. And in cases where you lack experience do not shrink from drawing them from nature. But, to carry out my promise above [in the title] — I say that when you paint you should have a flat mirror and often look at your work as reflected in it, when you will see it reversed, and it will appear to you like some other painter's work, so you will be better able to judge of its faults than in any other way. Again, it is well that you should often leave off work and take a little relaxation, because, when you come back to it you are a better judge; for sitting too close at work may greatly deceive you. Again, it is good to retire to a distance because the work looks smaller and your eye takes in more of it at a glance and sees more easily the discords or disproportion in the limbs and colours of the objects.

On the management of works (531. 532).

531.

OF A METHOD OF LEARNING WELL BY HEART.

When you want to know a thing you have studied in your memory proceed in this way: When you have drawn the same thing so many times that you think you know it by heart, test it by drawing it without the model; but have the model traced on flat thin glass and lay this on the drawing you have made without the model, and note carefully where the tracing does not coincide with your drawing, and where you find you have gone wrong; and bear in mind not to repeat the same mistakes. Then return to the model, and draw the part in which you were wrong again and again till you have it well in your mind. If you have no flat glass for tracing on, take some very thin kidts-kin parchment, well oiled and dried. And when you have used it for one drawing you can wash it clean with a sponge and make a second.

532.

THAT A PAINTER OUGHT TO BE CURIOUS TO HEAR THE OPINIONS OF EVERY ONE ON HIS WORK.

Certainly while a man is painting he ought not to shrink from hearing every opinion. For we know very well that a man, though he may not be a painter, is familiar with the forms of other men and very capable of judging whether they are hump backed, or have one shoulder higher or lower than the other, or too big a mouth or nose, and other defects; and, as we know that men are competent to judge of the works of nature, how much more ought we to admit that they can judge of our errors; since you know how much a man may be deceived in his own work. And if you are not conscious of this in yourself study it in others and profit by their faults. Therefore be curious to hear with patience the opinions of others, consider and weigh well whether those who find fault have ground or not for blame, and, if so amend; but, if not make as though you had not heard, or if he should be a man you esteem show him by argument the cause of his mistake.

On the limitations of painting (533-535)

533.

HOW IN SMALL OBJECTS ERRORS ARE LESS EVIDENT THAN IN

LARGE ONES.

In objects of minute size the extent of error is not so perceptible as in large ones; and the reason is that if this small object is a representation of a man or of some other animal, from the immense diminution the details cannot be worked out by the artist with the finish that is requisite. Hence it is not actually complete; and, not being complete, its faults cannot be determined. For instance: Look at a man at a distance of 300 braccia and judge attentively whether he be handsome or ugly, or very remarkable or of ordinary appearance. You will find that with the utmost effort you cannot persuade yourself to decide. And the reason is that at such a distance the man is so much diminished that the character of the details cannot be determined. And if you wish to see how much this man is diminished [by distance] hold one of your fingers at a span's distance from your eye, and raise or lower it till the top joint touches the feet of the figure you are looking at, and you will see an incredible reduction. For this reason we often doubt as to the person of a friend at a distance.

534.

WHY A PAINTING CAN NEVER APPEAR DETACHED AS NATURAL OBJECTS DO.

Painters often fall into despair of imitating nature when they see their pictures fail in that relief and vividness which objects have that are seen in a mirror; while they allege that they have colours which for brightness or depth far exceed the strength of light and shade in the reflections in the mirror, thus displaying their own ignorance rather than the real cause, because they do not know it. It is impossible that painted objects should appear in such relief as to resemble those reflected in the mirror, although both are seen on a flat surface, unless they are seen with only one eye; and the reason is that two eyes see one object behind another as a and b see m and n . m cannot exactly occupy [the space of] n because the base of the visual lines is so broad that the second body is seen beyond the first. But if you close one eye, as at s the body f will conceal r , because the line of sight proceeds from a single point and makes its base in the first body, whence the second, of the same size, can never be seen.

[Footnote: This passage contains the solution of the problem proposed in No. 29, lines 10-14. Leonardo was evidently familiar with the law of optics on which the construction of the stereoscope depends. Compare E. VON BRUCKE, *Bruchstücke aus der Theorie der bildenden Künste*, pg. 69: “Schon Leonardo da

Vinci wusste, dass ein noch so gut gemaltes Bild nie den vollen Eindruck der Körperlichkeit geben kann, wie ihn die Natur selbst giebt. Er erklärt dies auch in Kap. LIII und Kap. CCCXLI (ed. DU FRESNE) des ‘Trattato’ in sachgemasser Weise aus dem Sehen mit beiden Augen.”

Chap. 53 of DU FRESNE’S edition corresponds to No. 534 of this work.]

535.

WHY OF TWO OBJECTS OF EQUAL SIZE A PAINTED ONE WILL LOOK LARGER THAN A SOLID ONE.

The reason of this is not so easy to demonstrate as many others. Still I will endeavour to accomplish it, if not wholly, at any rate in part. The perspective of diminution demonstrates by reason, that objects diminish in proportion as they are farther from the eye, and this reasoning is confirmed by experience. Hence, the lines of sight that extend between the object and the eye, when they are directed to the surface of a painting are all intersected at uniform limits, while those lines which are directed towards a piece of sculpture are intersected at various limits and are of various lengths. The lines which are longest extend to a more remote limb than the others and therefore that limb looks smaller. As there are numerous lines each longer than the others — since there are numerous parts, each more remote than the others and these, being farther off, necessarily appear smaller, and by appearing smaller it follows that their diminution makes the whole mass of the object look smaller. But this does not occur in painting; since the lines of sight all end at the same distance there can be no diminution, hence the parts not being diminished the whole object is undiminished, and for this reason painting does not diminish, as a piece of sculpture does.

On the choice of a position (536-537)

536.

HOW HIGH THE POINT OF SIGHT SHOULD BE PLACED.

The point of sight must be at the level of the eye of an ordinary man, and the farthest limit of the plain where it touches the sky must be placed at the level of that line where the earth and sky meet; excepting mountains, which are

independent of it.

537.

OF THE WAY TO DRAW FIGURES FOR HISTORICAL PICTURES.

The painter must always study on the wall on which he is to picture a story the height of the position where he wishes to arrange his figures; and when drawing his studies for them from nature he must place himself with his eye as much below the object he is drawing as, in the picture, it will have to be above the eye of the spectator. Otherwise the work will look wrong.

The apparent size of figures in a picture (538-539)

538.

OF PLACING A FIGURE IN THE FOREGROUND OF A HISTORICAL PICTURE.

You must make the foremost figure in the picture less than the size of nature in proportion to the number of braccia at which you place it from the front line, and make the others in proportion by the above rule.

539.

PERSPECTIVE.

You are asked, O Painter, why the figures you draw on a small scale according to the laws of perspective do not appear — notwithstanding the demonstration of distance — as large as real ones — their height being the same as in those painted on the wall.

And why [painted] objects seen at a small distance appear larger than the real ones?

The right position of the artist, when painting, and of the spectator (540-547)

540.

OF PAINTING.

When you draw from nature stand at a distance of 3 times the height of the

object you wish to draw.

541.

OF DRAWING FROM RELIEF.

In drawing from the round the draughtsman should so place himself that the eye of the figure he is drawing is on a level with his own. This should be done with any head he may have to represent from nature because, without exception, the figures or persons you meet in the streets have their eyes on the same level as your own; and if you place them higher or lower you will see that your drawing will not be true.

542.

WHY GROUPS OF FIGURES ONE ABOVE ANOTHER ARE TO BE AVOIDED.

The universal practice which painters adopt on the walls of chapels is greatly and reasonably to be condemned. Inasmuch as they represent one historical subject on one level with a landscape and buildings, and then go up a step and paint another, varying the point [of sight], and then a third and a fourth, in such a way as that on one wall there are 4 points of sight, which is supreme folly in such painters. We know that the point of sight is opposite the eye of the spectator of the scene; and if you would [have me] tell you how to represent the life of a saint divided into several pictures on one and the same wall, I answer that you must set out the foreground with its point of sight on a level with the eye of the spectator of the scene, and upon this plane represent the more important part of the story large and then, diminishing by degrees the figures, and the buildings on various hills and open spaces, you can represent all the events of the history. And on the remainder of the wall up to the top put trees, large as compared with the figures, or angels if they are appropriate to the story, or birds or clouds or similar objects; otherwise do not trouble yourself with it for your whole work will be wrong.

543.

A PICTURE OF OBJECTS IN PERSPECTIVE

WILL LOOK MORE LIFELIKE WHEN SEEN FROM THE POINT FROM WHICH THE OBJECTS WERE DRAWN.

If you want to represent an object near to you which is to have the effect of nature, it is impossible that your perspective should not look wrong, with every false relation and disagreement of proportion that can be imagined in a wretched work, unless the spectator, when he looks at it, has his eye at the very distance and height and direction where the eye or the point of sight was placed in doing this perspective. Hence it would be necessary to make a window, or rather a hole, of the size of your face through which you can look at the work; and if you do this, beyond all doubt your work, if it is correct as to light and shade, will have the effect of nature; nay you will hardly persuade yourself that those objects are painted; otherwise do not trouble yourself about it, unless indeed you make your view at least 20 times as far off as the greatest width or height of the objects represented, and this will satisfy any spectator placed anywhere opposite to the picture.

If you want the proof briefly shown, take a piece of wood in the form of a little column, eight times as high as it is thick, like a column without any plinth or capital; then mark off on a flat wall 40 equal spaces, equal to its width so that between them they make 40 columns resembling your little column; you then must fix, opposite the centre space, and at 4 braccia from the wall, a thin strip of iron with a small round hole in the middle about as large as a big pearl. Close to this hole place a light touching it. Then place your column against each mark on the wall and draw the outline of its shadow; afterwards shade it and look through the hole in the iron plate.

[Footnote: In the original there is a wide space between lines 3 and 4 in which we find two sketches not belonging to the text. It is unnecessary to give prominence to the points in which my reading differs from that of M. RAVAISSON or to justify myself, since they are all of secondary importance and can also be immediately verified from the photograph facsimile in his edition.]

A diminished object should be seen from the same distance, height and direction as the point of sight of your eye, or else your knowledge will produce

no good effect.

And if you will not, or cannot, act on this principle — because as the plane on which you paint is to be seen by several persons you would need several points of sight which would make it look discordant and wrong — place yourself at a distance of at least 10 times the size of the objects.

The lesser fault you can fall into then, will be that of representing all the objects in the foreground of their proper size, and on whichever side you are standing the objects thus seen will diminish themselves while the spaces between them will have no definite ratio. For, if you place yourself in the middle of a straight row [of objects], and look at several columns arranged in a line you will see, beyond a few columns separated by intervals, that the columns touch; and beyond where they touch they cover each other, till the last column projects but very little beyond the last but one. Thus the spaces between the columns are by degrees entirely lost. So, if your method of perspective is good, it will produce the same effect; this effect results from standing near the line in which the columns are placed. This method is not satisfactory unless the objects seen are viewed from a small hole, in the middle of which is your point of sight; but if you proceed thus your work will be perfect and will deceive the beholder, who will see the columns as they are here figured.

Here the eye is in the middle, at the point *a* and near to the columns.

[Footnote: The diagram which stands above this chapter in the original with the note belonging to it: “*a b e la ripruova*” (*a b* is the proof) has obviously no connection with the text. The second sketch alone is reproduced and stands in the original between lines 22 and 23.]

545.

If you cannot arrange that those who look at your work should stand at one particular point, when constructing your work, stand back until your eye is at least 20 times as far off as the greatest height and width of your work. This will make so little difference when the eye of the spectator moves, that it will be hardly appreciable, and it will look very good.

If the point of sight is at *t* you would make the figures on the circle *d b e* all of one size, as each of them bears the same relation to the point *t*. But consider the diagram given below and you will see that this is wrong, and why I shall make *b* smaller than *d e* [Footnote 8: The second diagram of this chapter stands in the original between lines 8 and 9.].

It is easy to understand that if 2 objects equal to each other are placed side by

side the one at 3 braccia distance looks smaller than that placed at 2 braccia. This however is rather theoretical than for practice, because you stand close by [Footnote 11: Instead of '*se preso*' (= *sie presso*) M. RAVAISSON reads '*sempre se*' which gives rise to the unmeaning rendering: '*parceque toujours ...*'].

All the objects in the foreground, whether large or small, are to be drawn of their proper size, and if you see them from a distance they will appear just as they ought, and if you see them close they will diminish of themselves.

[Footnote 15: Compare No. 526 line 18.] Take care that the vertical plan on which you work out the perspective of the objects seen is of the same form as the wall on which the work is to be executed.

546.

OF PAINTING.

The size of the figures represented ought to show you the distance they are seen from. If you see a figure as large as nature you know it appears to be close to the eye.

547.

WHERE A SPECTATOR SHOULD STAND TO LOOK AT A PICTURE.

Supposing *a b* to be the picture and *d* to be the light, I say that if you place yourself between *c* and *e* you will not understand the picture well and particularly if it is done in oils, or still more if it is varnished, because it will be lustrous and somewhat of the nature of a mirror. And for this reason the nearer you go towards the point *c*, the less you will see, because the rays of light falling from the window on the picture are reflected to that point. But if you place yourself between *e* and *d* you will get a good view of it, and the more so as you approach the point *d*, because that spot is least exposed to these reflected rays of light.

III.

THE PRACTICAL METHODS OF LIGHT AND SHADE AND AERIAL PERSPECTIVE.

Gradations of light and shade.

548.

OF PAINTING: OF THE DARKNESS OF THE SHADOWS, OR I MAY SAY, THE BRIGHTNESS OF THE LIGHTS.

Although practical painters attribute to all shaded objects — trees, fields, hair, beards and skin — four degrees of darkness in each colour they use: that is to say first a dark foundation, secondly a spot of colour somewhat resembling the form of the details, thirdly a somewhat brighter and more defined portion, fourthly the lights which are more conspicuous than other parts of the figure; still to me it appears that these gradations are infinite upon a continuous surface which is in itself infinitely divisible, and I prove it thus: — [Footnote 7: See Pl. XXXI, No. 1; the two upper sketches.] Let ag be a continuous surface and let d be the light which illuminates it; I say — by the 4th [proposition] which says that that side of an illuminated body is most highly lighted which is nearest to the source of light — that therefore g must be darker than c in proportion as the line dg is longer than the line dc , and consequently that these gradations of light — or rather of shadow, are not 4 only, but may be conceived of as infinite, because cd is a continuous surface and every continuous surface is infinitely divisible; hence the varieties in the length of lines extending between the light and the illuminated object are infinite, and the proportion of the light will be the same as that of the length of the lines between them; extending from the centre of the luminous body to the surface of the illuminated object.

On the choice of light for a picture (549-554).

549.

HOW THE PAINTER MUST PLACE HIMSELF WITH REFERENCE TO THE LIGHT, TO GIVE THE EFFECT OF RELIEF.

Let ab be the window, m the point of light. I say that on whichever side the painter places himself he will be well placed if only his eye is between the

shaded and the illuminated portions of the object he is drawing; and this place you will find by putting yourself between the point *m* and the division between the shadow and the light on the object to be drawn.

550.

THAT SHADOWS CAST BY A PARTICULAR LIGHT SHOULD BE AVOIDED, BECAUSE THEY ARE EQUALLY STRONG AT THE ENDS AND AT THE BEGINNING.

The shadows cast by the sun or any other particular light have not a pleasing effect on the body to which they belong, because the parts remain confuse, being divided by distinct outlines of light and shade. And the shadows are of equal strength at the end and at the beginning.

551.

HOW LIGHT SHOULD BE THROWN UPON FIGURES.

The light must be arranged in accordance with the natural conditions under which you wish to represent your figures: that is, if you represent them in the sunshine make the shadows dark with large spaces of light, and mark their shadows and those of all the surrounding objects strongly on the ground. And if you represent them as in dull weather give little difference of light and shade, without any shadows at their feet. If you represent them as within doors, make a strong difference between the lights and shadows, with shadows on the ground. If the window is screened and the walls white, there will be little difference of light. If it is lighted by firelight make the high lights ruddy and strong, and the shadows dark, and those cast on the walls and on the floor will be clearly defined and the farther they are from the body the broader and longer will they be. If the light is partly from the fire and partly from the outer day, that of day will be the stronger and that of the fire almost as red as fire itself. Above all see that the figures you paint are broadly lighted and from above, that is to say all living persons that you paint; for you will see that all the people you meet out in the street are lighted from above, and you must know that if you saw your most intimate friend with a light [on his face] from below you would find it difficult

to recognise him.

552.

OF HELPING THE APPARENT RELIEF OF A PICTURE BY GIVING IT ARTIFICIAL LIGHT AND SHADE.

To increase relief of a picture you may place, between your figure and the solid object on which its shadow falls, a line of bright light, dividing the figure from the object in shadow. And on the same object you shall represent two light parts which will surround the shadow cast upon the wall by the figure placed opposite ; and do this frequently with the limbs which you wish should stand out somewhat from the body they belong to; particularly when the arms cross the front of the breast show, between the shadow cast by the arms on the breast and the shadow on the arms themselves, a little light seeming to fall through a space between the breast and the arms; and the more you wish the arm to look detached from the breast the broader you must make the light; always contrive also to arrange the figures against the background in such a way as that the parts in shadow are against a light background and the illuminated portions against a dark background.

[Footnote 6: Compare the two diagrams under No. 565.]

553.

OF SITUATION.

Remember [to note] the situation of your figures; for the light and shade will be one thing if the object is in a dark place with a particular light, and another thing if it is in a light place with direct sunlight; one thing in a dark place with a diffused evening light or a cloudy sky, and another in the diffused light of the atmosphere lighted by the sun.

554.

OF THE JUDGMENT TO BE MADE OF A PAINTER'S WORK.

First you must consider whether the figures have the relief required by their situation and the light which illuminates them; for the shadows should not be the same at the extreme ends of the composition as in the middle, because it is one thing when figures are surrounded by shadows and another when they have shadows only on one side. Those which are in the middle of the picture are surrounded by shadows, because they are shaded by the figures which stand between them and the light. And those are lighted on one side only which stand between the principal group and the light, because where they do not look towards the light they face the group and the darkness of the group is thrown on them: and where they do not face the group they face the brilliant light and it is their own darkness shadowing them, which appears there.

In the second place observe the distribution or arrangement of figures, and whether they are distributed appropriately to the circumstances of the story. Thirdly, whether the figures are actively intent on their particular business.

555.

OF THE TREATMENT OF THE LIGHTS.

First give a general shadow to the whole of that extended part which is away from the light. Then put in the half shadows and the strong shadows, comparing them with each other and, in the same way give the extended light in half tint, afterwards adding the half lights and the high lights, likewise comparing them together.

The distribution of light and shade (556-559)

556.

OF SHADOWS ON BODIES.

When you represent the dark shadows in bodies in light and shade, always show the cause of the shadow, and the same with reflections; because the dark shadows are produced by dark objects and the reflections by objects only moderately lighted, that is with diminished light. And there is the same proportion between the highly lighted part of a body and the part lighted by a reflection as between the origin of the lights on the body and the origin of the reflections.

557.

OF LIGHTS AND SHADOWS.

I must remind you to take care that every portion of a body, and every smallest detail which is ever so little in relief, must be given its proper importance as to light and shade.

558.

OF THE WAY TO MAKE THE SHADOW ON FIGURES CORRESPOND TO THE LIGHT AND TO [THE COLOUR] OF THE BODY.

When you draw a figure and you wish to see whether the shadow is the proper complement to the light, and neither redder nor yellower than is the nature of the colour you wish to represent in shade, proceed thus. Cast a shadow with your finger on the illuminated portion, and if the accidental shadow that you have made is like the natural shadow cast by your finger on your work, well and good; and by putting your finger nearer or farther off, you can make darker or lighter shadows, which you must compare with your own.

559.

OF SURROUNDING BODIES BY VARIOUS FORMS OF SHADOW.

Take care that the shadows cast upon the surface of the bodies by different objects must undulate according to the various curves of the limbs which cast the shadows, and of the objects on which they are cast.

The juxtaposition of light and shade (560, 561).

560.

ON PAINTING.

The comparison of the various qualities of shadows and lights not infrequently seems ambiguous and confused to the painter who desires to imitate and copy the objects he sees. The reason is this: If you see a white drapery side by side

with a black one, that part of the white drapery which lies against the black one will certainly look much whiter than the part which lies against something whiter than itself. [Footnote: It is evident from this that so early as in 1492 Leonardo's writing in perspective was so far advanced that he could quote his own statements. — As bearing on this subject compare what is said in No. 280.] And the reason of this is shown in my [book on] perspective.

561.

OF SHADOWS.

Where a shadow ends in the light, note carefully where it is paler or deeper and where it is more or less indistinct towards the light; and, above all, in [painting] youthful figures I remind you not to make the shadow end like a stone, because flesh has a certain transparency, as may be seen by looking at a hand held between the eye and the sun, which shines through it ruddy and bright. Place the most highly coloured part between the light and shadow. And to see what shadow tint is needed on the flesh, cast a shadow on it with your finger, and according as you wish to see it lighter or darker hold your finger nearer to or farther from your picture, and copy that [shadow].

On the lighting of the background (562-565).

562.

OF THE BACKGROUNDS FOR PAINTED FIGURES.

The ground which surrounds the forms of any object you paint should be darker than the high lights of those figures, and lighter than their shadowed part: &c.

563.

OF THE BACKGROUND THAT THE PAINTER SHOULD ADOPT IN HIS WORKS.

Since experience shows us that all bodies are surrounded by light and shade it is necessary that you, O Painter, should so arrange that the side which is in light shall terminate against a dark body and likewise that the shadow side shall terminate against a light body. And by [following] this rule you will add greatly to the relief of your figures.

A most important part of painting consists in the backgrounds of the objects represented; against these backgrounds the outlines of those natural objects which are convex are always visible, and also the forms of these bodies against the background, even though the colours of the bodies should be the same as that of the background. This is caused by the convex edges of the objects not being illuminated in the same way as, by the same light, the background is illuminated, since these edges will often be lighter or darker than the background. But if the edge is of the same colour as the background, beyond a doubt it will in that part of the picture interfere with your perception of the outline, and such a choice in a picture ought to be rejected by the judgment of good painters, inasmuch as the purpose of the painter is to make his figures appear detached from the background; while in the case here described the contrary occurs, not only in the picture, but in the objects themselves.

That you ought, when representing objects above the eye and on one side — if you wish them to look detached from the wall — to show, between the shadow on the object and the shadow it casts a middle light, so that the body will appear to stand away from the wall.

On the lighting of white objects.

HOW WHITE BODIES SHOULD BE REPRESENTED.

If you are representing a white body let it be surrounded by ample space, because as white has no colour of its own, it is tinged and altered in some degree by the colour of the objects surrounding it. If you see a woman dressed in white in the midst of a landscape, that side which is towards the sun is bright in colour, so much so that in some portions it will dazzle the eyes like the sun itself; and the side which is towards the atmosphere, — luminous through being interwoven with the sun's rays and penetrated by them — since the atmosphere itself is blue, that side of the woman's figure will appear steeped in blue. If the surface of the ground about her be meadows and if she be standing between a field lighted up by the sun and the sun itself, you will see every portion of those folds which are

towards the meadow tinged by the reflected rays with the colour of that meadow. Thus the white is transmuted into the colours of the luminous and of the non-luminous objects near it.

The methods of aerial (567 — 570).

567.

WHY FACES [SEEN] AT A DISTANCE LOOK DARK.

We see quite plainly that all the images of visible objects that lie before us, whether large or small, reach our sense by the minute aperture of the eye; and if, through so small a passage the image can pass of the vast extent of sky and earth, the face of a man — being by comparison with such large images almost nothing by reason of the distance which diminishes it, — fills up so little of the eye that it is indistinguishable. Having, also, to be transmitted from the surface to the sense through a dark medium, that is to say the crystalline lens which looks dark, this image, not being strong in colour becomes affected by this darkness on its passage, and on reaching the sense it appears dark; no other reason can in any way be assigned. If the point in the eye is black, it is because it is full of a transparent humour as clear as air and acts like a perforation in a board; on looking into it it appears dark and the objects seen through the bright air and a dark one become confused in this darkness.

WHY A MAN SEEN AT A CERTAIN DISTANCE IS NOT RECOGNISABLE.

The perspective of diminution shows us that the farther away an object is the smaller it looks. If you look at a man at a distance from you of an arrow's flight, and hold the eye of a small needle close to your own eye, you can see through it several men whose images are transmitted to the eye and will all be comprised within the size of the needle's eye; hence, if the man who is at the distance of an arrow's flight can send his whole image to your eye, occupying only a small space in the needle's eye how can you [expect] in so small a figure to distinguish or see the nose or mouth or any detail of his person? and, not seeing these you cannot recognise the man, since these features, which he does not show, are what give men different aspects.

568.

THE REASON WHY SMALL FIGURES SHOULD NOT BE MADE FINISHED.

I say that the reason that objects appear diminished in size is because they are remote from the eye; this being the case it is evident that there must be a great extent of atmosphere between the eye and the objects, and this air interferes with the distinctness of the forms of the object. Hence the minute details of these objects will be indistinguishable and unrecognisable. Therefore, O Painter, make your smaller figures merely indicated and not highly finished, otherwise you will produce effects the opposite to nature, your supreme guide. The object is small by reason of the great distance between it and the eye, this great distance is filled with air, that mass of air forms a dense body which intervenes and prevents the eye seeing the minute details of objects.

569.

Whenever a figure is placed at a considerable distance you lose first the distinctness of the smallest parts; while the larger parts are left to the last, losing all distinctness of detail and outline; and what remains is an oval or spherical figure with confused edges.

570.

OF PAINTING.

The density of a body of smoke looks white below the horizon while above the horizon it is dark, even if the smoke is in itself of a uniform colour, this uniformity will vary according to the variety in the ground on which it is seen.

IV.

OF PORTRAIT AND FIGURE PAINTING.

Of sketching figures and portraits (571-572).

571.

OF THE WAY TO LEARN TO COMPOSE FIGURES [IN GROUPS] IN HISTORICAL PICTURES.

When you have well learnt perspective and have by heart the parts and forms of objects, you must go about, and constantly, as you go, observe, note and consider the circumstances and behaviour of men in talking, quarrelling or laughing or fighting together: the action of the men themselves and the actions of the bystanders, who separate them or who look on. And take a note of them with slight strokes thus, in a little book which you should always carry with you. And it should be of tinted paper, that it may not be rubbed out, but change the old [when full] for a new one; since these things should not be rubbed out but preserved with great care; for the forms, and positions of objects are so infinite that the memory is incapable of retaining them, wherefore keep these [sketches] as your guides and masters.

[Footnote: Among Leonardo's numerous note books of pocket size not one has coloured paper, so no sketches answering to this description can be pointed out. The fact that most of the notes are written in ink, militates against the supposition that they were made in the open air.]

572.

OF A METHOD OF KEEPING IN MIND THE FORM OF A FACE.

If you want to acquire facility for bearing in mind the expression of a face, first make yourself familiar with a variety of [forms of] several heads, eyes, noses, mouths, chins and cheeks and necks and shoulders: And to put a case: Noses are of 10 types: straight, bulbous, hollow, prominent above or below the middle, aquiline, regular, flat, round or pointed. These hold good as to profile. In full face they are of 11 types; these are equal thick in the middle, thin in the middle, with the tip thick and the root narrow, or narrow at the tip and wide at the root; with the nostrils wide or narrow, high or low, and the openings wide or hidden by the point; and you will find an equal variety in the other details; which things you must draw from nature and fix them in your mind. Or else, when you have to draw a face by heart, carry with you a little book in which you have noted such features; and when you have cast a glance at the face of the person you

wish to draw, you can look, in private, which nose or mouth is most like, or there make a little mark to recognise it again at home. Of grotesque faces I need say nothing, because they are kept in mind without difficulty.

The position of the head.

573.

HOW YOU SHOULD SET TO WORK TO DRAW A HEAD OF WHICH ALL THE PARTS SHALL AGREE WITH THE POSITION GIVEN TO IT.

To draw a head in which the features shall agree with the turn and bend of the head, pursue this method. You know that the eyes, eyebrows, nostrils, corners of the mouth, and sides of the chin, the jaws, cheeks, ears and all the parts of a face are squarely and straightly set upon the face.

[Footnote: Compare the drawings and the text belonging to them on Pl. IX. (No. 315), Pl. X (No. 316), Pl. XL (No. 318) and Pl. XII. (No. 319).]

Therefore when you have sketched the face draw lines passing from one corner of the eye to the other; and so for the placing of each feature; and after having drawn the ends of the lines beyond the two sides of the face, look if the spaces inside the same parallel lines on the right and on the left are equal. But be sure to remember to make these lines tend to the point of sight.

[Footnote: See Pl. XXXI, No. 4, the slight sketch on the left hand side. The text of this passage is written by the side of it. In this sketch the lines seem intentionally incorrect and converging to the right (compare I. 12) instead of parallel. Compare too with this text the drawing in red chalk from Windsor Castle which is reproduced on Pl. XL, No. 2.]

Of the light on the face (574-576).

574.

HOW TO KNOW WHICH SIDE OF AN OBJECT IS TO BE MORE OR LESS LUMINOUS THAN THE OTHER.

Let f be the light, the head will be the object illuminated by it and that side of the head on which the rays fall most directly will be the most highly lighted, and those parts on which the rays fall most aslant will be less lighted. The light falls as a blow might, since a blow which falls perpendicularly falls with the greatest force, and when it falls obliquely it is less forcible than the former in proportion to the width of the angle. *Exempli gratia* if you throw a ball at a wall of which the extremities are equally far from you the blow will fall straight, and if you throw the ball at the wall when standing at one end of it the ball will hit it obliquely and the blow will not tell.

[Footnote: See Pl. XXXI. No. 4; the sketch on the right hand side.]

575.

THE PROOF AND REASON WHY AMONG THE ILLUMINATED PARTS CERTAIN PORTIONS ARE IN HIGHER LIGHT THAN OTHERS.

Since it is proved that every definite light is, or seems to be, derived from one single point the side illuminated by it will have its highest light on the portion where the line of radiance falls perpendicularly; as is shown above in the lines ag , and also in ah and in la ; and that portion of the illuminated side will be least luminous, where the line of incidence strikes it between two more dissimilar angles, as is seen at bcd . And by this means you may also know which parts are deprived of light as is seen at mk .

Where the angles made by the lines of incidence are most equal there will be the highest light, and where they are most unequal it will be darkest.

I will make further mention of the reason of reflections.

[Footnote: See Pl. XXXII. The text, here given complete, is on the right hand side. The small circles above the beginning of lines 5 and 11 as well as the circle above the text on Pl. XXXI, are in a paler ink and evidently added by a later hand in order to distinguish the text as belonging to the *Libro di Pittura* (see Prolegomena. No. 12, p. 3). The text on the left hand side of this page is given as Nos. 577 and 137.]

576.

Where the shadow should be on the face.

General suggestions for historical pictures (577-581).

577.

When you compose a historical picture take two points, one the point of sight, and the other the source of light; and make this as distant as possible.

578.

Historical pictures ought not to be crowded and confused with too many figures.

579.

PRECEPTS IN PAINTING.

Let your sketches of historical pictures be swift and the working out of the limbs not be carried too far, but limited to the position of the limbs, which you can afterwards finish as you please and at your leisure.

[Footnote: See Pl. XXXVIII, No. 2. The pen and ink drawing given there as No. 3 may also be compared with this passage. It is in the Windsor collection where it is numbered 101.]

580.

The sorest misfortune is when your views are in advance of your work.

581.

Of composing historical pictures. Of not considering the limbs in the figures in historical pictures; as many do who, in the wish to represent the whole of a figure, spoil their compositions. And when you place one figure behind another take care to draw the whole of it so that the limbs which come in front of the nearer figures may stand out in their natural size and place.

How to represent the differences of age and sex (582-583).

582.

How the ages of man should be depicted: that is, Infancy, Childhood,

Youth, Manhood, Old age, Decrepitude.

[Footnote: No answer is here given to this question, in the original MS.]

583.

Old men ought to be represented with slow and heavy movements, their legs bent at the knees, when they stand still, and their feet placed parallel and apart; bending low with the head leaning forward, and their arms but little extended.

Women must be represented in modest attitudes, their legs close together, their arms closely folded, their heads inclined and somewhat on one side.

Old women should be represented with eager, swift and furious gestures, like infernal furies; but the action should be more violent in their arms and head than in their legs.

Little children, with lively and contorted movements when sitting, and, when standing still, in shy and timid attitudes.

[Footnote: *bracci raccolte*. Compare Pl. XXXIII. This drawing, in silver point on yellowish tinted paper, the lights heightened with white, represents two female hands laid together in a lap. Above is a third finished study of a right hand, apparently holding a veil from the head across the bosom. This drawing evidently dates from before 1500 and was very probably done at Florence, perhaps as a preparatory study for some picture. The type of hand with its slender thin forms is more like the style of the *Vierge aux Rochers* in the Louvre than any later works — as the *Mona Lisa* for instance.]

Of representing the emotions.

584.

THAT A FIGURE IS NOT ADMIRABLE UNLESS IT EXPRESSES BY ITS ACTION THE PASSION OF ITS SENTIMENT.

That figure is most admirable which by its actions best expresses the passion that animates it.

HOW AN ANGRY MAN IS TO BE FIGURED.

You must make an angry person holding someone by the hair, wrenching his head against the ground, and with one knee on his ribs; his right arm and fist raised on high. His hair must be thrown up, his brow downcast and knit, his teeth clenched and the two corners of his mouth grimly set; his neck swelled and bent forward as he leans over his foe, and full of furrows.

HOW TO REPRESENT A MAN IN DESPAIR.

You must show a man in despair with a knife, having already torn open his garments, and with one hand tearing open the wound. And make him standing on his feet and his legs somewhat bent and his whole person leaning towards the earth; his hair flying in disorder.

Of representing imaginary animals.

585.

HOW YOU SHOULD MAKE AN IMAGINARY ANIMAL LOOK NATURAL.

You know that you cannot invent animals without limbs, each of which, in itself, must resemble those of some other animal. Hence if you wish to make an animal, imagined by you, appear natural — let us say a Dragon, take for its head that of a mastiff or hound, with the eyes of a cat, the ears of a porcupine, the nose of a greyhound, the brow of a lion, the temples of an old cock, the neck of a water tortoise.

[Footnote: The sketch here inserted of two men on horseback fighting a dragon is the facsimile of a pen and ink drawing belonging to BARON EDMOND DE ROTHSCHILD of Paris.]

The selection of forms.

586.

OF THE DELUSIONS WHICH ARISE IN JUDGING OF THE LIMBS.

A painter who has clumsy hands will paint similar hands in his works, and the same will occur with any limb, unless long study has taught him to avoid it. Therefore, O Painter, look carefully what part is most ill-favoured in your own person and take particular pains to correct it in your studies. For if you are

coarse, your figures will seem the same and devoid of charm; and it is the same with any part that may be good or poor in yourself; it will be shown in some degree in your figures.

587.

OF THE SELECTION OF BEAUTIFUL FACES.

It seems to me to be no small charm in a painter when he gives his figures a pleasing air, and this grace, if he have it not by nature, he may acquire by incidental study in this way: Look about you and take the best parts of many beautiful faces, of which the beauty is confirmed rather by public fame than by your own judgment; for you might be mistaken and choose faces which have some resemblance to your own. For it would seem that such resemblances often please us; and if you should be ugly, you would select faces that were not beautiful and you would then make ugly faces, as many painters do. For often a master's work resembles himself. So select beauties as I tell you, and fix them in your mind.

588.

Of the limbs, which ought to be carefully selected, and of all the other parts with regard to painting.

589.

When selecting figures you should choose slender ones rather than lean and wooden ones.

590.

OF THE MUSCLES OF ANIMALS.

The hollow spaces interposed between the muscles must not be of such a character as that the skin should seem to cover two sticks laid side by side like *c*, nor should they seem like two sticks somewhat remote from such contact so that the skin hangs in an empty loose curve as at *f*; but it should be like *i*, laid over the spongy fat that lies in the angles as the angle *n m o*; which angle is formed by

the contact of the ends of the muscles and as the skin cannot fold down into such an angle, nature has filled up such angles with a small quantity of spongy and, as I may say, vesicular fat, with minute bladders [in it] full of air, which is condensed or rarefied in them according to the increase or the diminution of the substance of the muscles; in which latter case the concavity *i* always has a larger curve than the muscle.

591.

OF UNDULATING MOVEMENTS AND EQUIPOISE IN FIGURES AND OTHER ANIMALS.

When representing a human figure or some graceful animal, be careful to avoid a wooden stiffness; that is to say make them move with equipoise and balance so as not to look like a piece of wood; but those you want to represent as strong you must not make so, excepting in the turn of the head.

How to pose figures.

592.

OF GRACE IN THE LIMBS.

The limbs should be adapted to the body with grace and with reference to the effect that you wish the figure to produce. And if you wish to produce a figure that shall of itself look light and graceful you must make the limbs elegant and extended, and without too much display of the muscles; and those few that are needed for your purpose you must indicate softly, that is, not very prominent and without strong shadows; the limbs, and particularly the arms easy; that is, none of the limbs should be in a straight line with the adjoining parts. And if the hips, which are the pole of a man, are by reason of his position, placed so, that the right is higher than the left, make the point of the higher shoulder in a perpendicular line above the highest prominence of the hip, and let this right shoulder be lower than the left. Let the pit of the throat always be over the centre of the joint of the foot on which the man is leaning. The leg which is free should have the knee lower than the other, and near the other leg. The positions of the head and arms are endless and I shall therefore not enlarge on any rules for them. Still, let them be easy and pleasing, with various turns and twists, and the joints gracefully bent, that they may not look like pieces of wood.

Of appropriate gestures (593-600).

A picture or representation of human figures, ought to be done in such a way as that the spectator may easily recognise, by means of their attitudes, the purpose in their minds. Thus, if you have to represent a man of noble character in the act of speaking, let his gestures be such as naturally accompany good words; and, in the same way, if you wish to depict a man of a brutal nature, give him fierce movements; as with his arms flung out towards the listener, and his head and breast thrust forward beyond his feet, as if following the speaker's hands. Thus it is with a deaf and dumb person who, when he sees two men in conversation — although he is deprived of hearing — can nevertheless understand, from the attitudes and gestures of the speakers, the nature of their discussion. I once saw in Florence a man who had become deaf who, when you spoke very loud did not understand you, but if you spoke gently and without making any sound, understood merely from the movement of the lips. Now perhaps you will say that the lips of a man who speaks loudly do not move like those of one speaking softly, and that if they were to move them alike they would be alike understood. As to this argument, I leave the decision to experiment; make a man speak to you gently and note [the motion of] his lips.

[Footnote: The first ten lines of this text have already been published, but with a slightly different reading by Dr. M. JORDAN: *Das Malerbuch Leonardo da Vinci's* p. 86.]

OF REPRESENTING A MAN SPEAKING TO A MULTITUDE.

When you wish to represent a man speaking to a number of people, consider the matter of which he has to treat and adapt his action to the subject. Thus, if he speaks persuasively, let his action be appropriate to it. If the matter in hand be to set forth an argument, let the speaker, with the fingers of the right hand hold one finger of the left hand, having the two smaller ones closed; and his face alert, and turned towards the people with mouth a little open, to look as though he spoke; and if he is sitting let him appear as though about to rise, with his head forward. If you represent him standing make him leaning slightly forward with body and head towards the people. These you must represent as silent and attentive, all looking at the orator's face with gestures of admiration; and make some old men in astonishment at the things they hear, with the corners of their

mouths pulled down and drawn in, their cheeks full of furrows, and their eyebrows raised, and wrinkling the forehead where they meet. Again, some sitting with their fingers clasped holding their weary knees. Again, some bent old man, with one knee crossed over the other; on which let him hold his hand with his other elbow resting in it and the hand supporting his bearded chin.

[Footnote: The sketches introduced here are a facsimile of a pen and ink drawing in the Louvre which Herr CARL BRUN considers as studies for the Last Supper in the church of *Santa Maria delle Grazie* (see Leonardo da Vinci, LXI, pp. 21, 27 and 28 in DOHME'S *Kunst und Kunstler*, Leipzig, Seemann). I shall not here enter into any discussion of this suggestion; but as a justification for introducing the drawing in this place, I may point out that some of the figures illustrate this passage as perfectly as though they had been drawn for that express purpose. I have discussed the probability of a connection between this sketch and the picture of the Last Supper on p. 335. The original drawing is 27 3/4 centimetres wide by 21 high. — The drawing in silver point on reddish paper given on Pl. LII. No. 1 — the original at Windsor Castle — may also serve to illustrate the subject of appropriate gestures, treated in Nos. 593 and 594.]

595.

OF THE DISPOSITION OF LIMBS.

As regards the disposition of limbs in movement you will have to consider that when you wish to represent a man who, by some chance, has to turn backwards or to one side, you must not make him move his feet and all his limbs towards the side to which he turns his head. Rather must you make the action proceed by degrees and through the different joints; that is, those of the foot, the knee and the hip and the neck. And if you set him on the right leg, you must make the left knee bend inwards, and let his foot be slightly raised on the outside, and the left shoulder be somewhat lower than the right, while the nape of the neck is in a line directly over the outer angle of the left foot. And the left shoulder will be in a perpendicular line above the toes of the right foot. And always set your figures so that the side to which the head turns is not the side to which the breast faces, since nature for our convenience has made us with a neck which bends with ease in many directions, the eye wishing to turn to various points, the different joints. And if at any time you make a man sitting with his arms at work on something which is sideways to him, make the upper part of his body turn upon the hips.

[Footnote: Compare Pl. VII, No. 5. The original drawing at Windsor Castle is numbered 104.]

When you draw the nude always sketch the whole figure and then finish those limbs which seem to you the best, but make them act with the other limbs; otherwise you will get a habit of never putting the limbs well together on the body.

Never make the head turn the same way as the torso, nor the arm and leg move together on the same side. And if the face is turned to the right shoulder, make all the parts lower on the left side than on the right; and when you turn the body with the breast outwards, if the head turns to the left side make the parts on the right side higher than those on the left.

[Footnote: In the original MS. a much defaced sketch is to be seen by the side of the second part of this chapter; its faded condition has rendered reproduction impossible. In M. RAVAISSON'S facsimile the outlines of the head have probably been touched up. This passage however is fitly illustrated by the drawings on Pl. XXI.]

OF PAINTING.

Of the nature of movements in man. Do not repeat the same gestures in the limbs of men unless you are compelled by the necessity of their action, as is shown in *a b*.

[Footnote: See Pl. V, where part of the text is also reproduced. The effaced figure to the extreme left has evidently been cancelled by Leonardo himself as unsatisfactory.]

The motions of men must be such as suggest their dignity or their baseness.

OF PAINTING.

Make your work carry out your purpose and meaning. That is when you draw a figure consider well who it is and what you wish it to be doing.

OF PAINTING.

With regard to any action which you give in a picture to an old man or to a young one, you must make it more energetic in the young man in proportion as he is stronger than the old one; and in the same way with a young man and an infant.

600.

OF SETTING ON THE LIMBS.

The limbs which are used for labour must be muscular and those which are not much used you must make without muscles and softly rounded.

OF THE ACTION OF THE FIGURES.

Represent your figures in such action as may be fitted to express what purpose is in the mind of each; otherwise your art will not be admirable.

V.

SUGGESTIONS FOR COMPOSITIONS.

Of painting battle pieces (601-603).

601.

OF THE WAY OF REPRESENTING A BATTLE.

First you must represent the smoke of artillery mingling in the air with the dust and tossed up by the movement of horses and the combatants. And this mixture you must express thus: The dust, being a thing of earth, has weight; and although from its fineness it is easily tossed up and mingles with the air, it nevertheless readily falls again. It is the finest part that rises highest; hence that part will be least seen and will look almost of the same colour as the air. The higher the smoke mixed with the dust-laden air rises towards a certain level, the more it

will look like a dark cloud; and it will be seen that at the top, where the smoke is more separate from the dust, the smoke will assume a bluish tinge and the dust will tend to its colour. This mixture of air, smoke and dust will look much lighter on the side whence the light comes than on the opposite side. The more the combatants are in this turmoil the less will they be seen, and the less contrast will there be in their lights and shadows. Their faces and figures and their appearance, and the musketeers as well as those near them you must make of a glowing red. And this glow will diminish in proportion as it is remote from its cause.

The figures which are between you and the light, if they be at a distance, will appear dark on a light background, and the lower part of their legs near the ground will be least visible, because there the dust is coarsest and densest . And if you introduce horses galloping outside the crowd, make the little clouds of dust distant from each other in proportion to the strides made by the horses; and the clouds which are furthest removed from the horses, should be least visible; make them high and spreading and thin, and the nearer ones will be more conspicuous and smaller and denser . The air must be full of arrows in every direction, some shooting upwards, some falling, some flying level. The balls from the guns must have a train of smoke following their flight. The figures in the foreground you must make with dust on the hair and eyebrows and on other flat places likely to retain it. The conquerors you will make rushing onwards with their hair and other light things flying on the wind, with their brows bent down, [Footnote: 19 — 23. Compare 608. 57 — 75.]

602.

and with the opposite limbs thrust forward; that is where a man puts forward the right foot the left arm must be advanced. And if you make any one fallen, you must show the place where he has slipped and been dragged along the dust into blood stained mire; and in the half-liquid earth arround show the print of the tramping of men and horses who have passed that way. Make also a horse dragging the dead body of his master, and leaving behind him, in the dust and mud, the track where the body was dragged along. You must make the conquered and beaten pale, their brows raised and knit, and the skin above their brows furrowed with pain, the sides of the nose with wrinkles going in an arch from the nostrils to the eyes, and make the nostrils drawn up — which is the cause of the lines of which I speak — , and the lips arched upwards and discovering the upper teeth; and the teeth apart as with crying out and

lamentation. And make some one shielding his terrified eyes with one hand, the palm towards the enemy, while the other rests on the ground to support his half raised body. Others represent shouting with their mouths open, and running away. You must scatter arms of all sorts among the feet of the combatants, as broken shields, lances, broken swords and other such objects. And you must make the dead partly or entirely covered with dust, which is changed into crimson mire where it has mingled with the flowing blood whose colour shows it issuing in a sinuous stream from the corpse. Others must be represented in the agonies of death grinding their teeth, rolling their eyes, with their fists clenched against their bodies and their legs contorted. Some might be shown disarmed and beaten down by the enemy, turning upon the foe, with teeth and nails, to take an inhuman and bitter revenge. You might see some riderless horse rushing among the enemy, with his mane flying in the wind, and doing no little mischief with his heels. Some maimed warrior may be seen fallen to the earth, covering himself with his shield, while the enemy, bending over him, tries to deal him a deathstroke. There again might be seen a number of men fallen in a heap over a dead horse. You would see some of the victors leaving the fight and issuing from the crowd, rubbing their eyes and cheeks with both hands to clean them of the dirt made by their watering eyes smarting from the dust and smoke. The reserves may be seen standing, hopeful but cautious; with watchful eyes, shading them with their hands and gazing through the dense and murky confusion, attentive to the commands of their captain. The captain himself, his staff raised, hurries towards these auxiliaries, pointing to the spot where they are most needed. And there may be a river into which horses are galloping, churning up the water all round them into turbulent waves of foam and water, tossed into the air and among the legs and bodies of the horses. And there must not be a level spot that is not trampled with gore.

603.

OF LIGHTING THE LOWER PARTS OF BODIES CLOSE TOGETHER, AS OF MEN IN BATTLE.

As to men and horses represented in battle, their different parts will be dark in proportion as they are nearer to the ground on which they stand. And this is proved by the sides of wells which grow darker in proportion to their depth, the reason of which is that the deepest part of the well sees and receives a smaller amount of the luminous atmosphere than any other part.

And the pavement, if it be of the same colour as the legs of these said men and horses, will always be more lighted and at a more direct angle than the said legs &c.

604.

OF THE WAY TO REPRESENT A NIGHT [SCENE].

That which is entirely bereft of light is all darkness; given a night under these conditions and that you want to represent a night scene, — arrange that there shall be a great fire, then the objects which are nearest to this fire will be most tinged with its colour; for those objects which are nearest to a coloured light participate most in its nature; as therefore you give the fire a red colour, you must make all the objects illuminated by it ruddy; while those which are farther from the fire are more tinted by the black hue of night. The figures which are seen against the fire look dark in the glare of the firelight because that side of the objects which you see is tinged by the darkness of the night and not by the fire; and those who stand at the side are half dark and half red; while those who are visible beyond the edges of the flame will be fully lighted by the ruddy glow against a black background. As to their gestures, make those which are near it screen themselves with their hands and cloaks as a defence against the intense heat, and with their faces turned away as if about to retire. Of those farther off represent several as raising their hands to screen their eyes, hurt by the intolerable glare.

Of depicting a tempest (605. 606).

605.

Describe a wind on land and at sea. Describe a storm of rain.

606.

HOW TO REPRESENT A TEMPEST.

If you wish to represent a tempest consider and arrange well its effects as seen, when the wind, blowing over the face of the sea and earth, removes and carries with it such things as are not fixed to the general mass. And to represent the storm accurately you must first show the clouds scattered and torn, and flying

with the wind, accompanied by clouds of sand blown up from the sea shore, and boughs and leaves swept along by the strength and fury of the blast and scattered with other light objects through the air. Trees and plants must be bent to the ground, almost as if they would follow the course of the gale, with their branches twisted out of their natural growth and their leaves tossed and turned about [Footnote 11: See Pl. XL, No. 2.]. Of the men who are there some must have fallen to the ground and be entangled in their garments, and hardly to be recognized for the dust, while those who remain standing may be behind some tree, with their arms round it that the wind may not tear them away; others with their hands over their eyes for the dust, bending to the ground with their clothes and hair streaming in the wind. [Footnote 15: See Pl. XXXIV, the right hand lower sketch.] Let the sea be rough and tempestuous and full of foam whirled among the lofty waves, while the wind flings the lighter spray through the stormy air, till it resembles a dense and swathing mist. Of the ships that are therein some should be shown with rent sails and the tatters fluttering through the air, with ropes broken and masts split and fallen. And the ship itself lying in the trough of the sea and wrecked by the fury of the waves with the men shrieking and clinging to the fragments of the vessel. Make the clouds driven by the impetuosity of the wind and flung against the lofty mountain tops, and wreathed and torn like waves beating upon rocks; the air itself terrible from the deep darkness caused by the dust and fog and heavy clouds.

Of representing the deluge (607-609).

607.

TO REPRESENT THE DELUGE.

The air was darkened by the heavy rain whose oblique descent driven aslant by the rush of the winds, flew in drifts through the air not otherwise than as we see dust, varied only by the straight lines of the heavy drops of falling water. But it was tinged with the colour of the fire kindled by the thunderbolts by which the clouds were rent and shattered; and whose flashes revealed the broad waters of the inundated valleys, above which was seen the verdure of the bending tree tops. Neptune will be seen in the midst of the water with his trident, and let AEolus with his winds be shown entangling the trees floating uprooted, and whirling in the huge waves. The horizon and the whole hemisphere were obscure, but lurid from the flashes of the incessant lightning. Men and birds might be seen crowded on the tall trees which remained uncovered by the swelling waters, originators of the mountains which surround the great abysses

OF THE DELUGE AND HOW TO REPRESENT IT IN A PICTURE.

Let the dark and gloomy air be seen buffeted by the rush of contrary winds and dense from the continued rain mingled with hail and bearing hither and thither an infinite number of branches torn from the trees and mixed with numberless leaves. All round may be seen venerable trees, uprooted and stripped by the fury of the winds; and fragments of mountains, already scoured bare by the torrents, falling into those torrents and choking their valleys till the swollen rivers overflow and submerge the wide lowlands and their inhabitants. Again, you might have seen on many of the hill-tops terrified animals of different kinds, collected together and subdued to tameness, in company with men and women who had fled there with their children. The waters which covered the fields, with their waves were in great part strewn with tables, bedsteads, boats and various other contrivances made from necessity and the fear of death, on which were men and women with their children amid sounds of lamentation and weeping, terrified by the fury of the winds which with their tempestuous violence rolled the waters under and over and about the bodies of the drowned. Nor was there any object lighter than the water which was not covered with a variety of animals which, having come to a truce, stood together in a frightened crowd — among them wolves, foxes, snakes and others — fleeing from death. And all the waters dashing on their shores seemed to be battling them with the blows of drowned bodies, blows which killed those in whom any life remained . You might have seen assemblages of men who, with weapons in their hands, defended the small spots that remained to them against lions, wolves and beasts of prey who sought safety there. Ah! what dreadful noises were heard in the air rent by the fury of the thunder and the lightnings it flashed forth, which darted from the clouds dealing ruin and striking all that opposed its course. Ah! how many you might have seen closing their ears with their hands to shut out the tremendous sounds made in the darkened air by the raging of the winds mingling with the rain, the thunders of heaven and the fury of the thunderbolts. Others were not content with shutting their eyes, but laid their hands one over the other to cover them the closer that they might not see the cruel slaughter of the human race by the wrath of God. Ah! how many laments! and how many in their terror flung themselves from the rocks! Huge branches of great oaks loaded with men were seen borne through the air by the impetuous fury of the winds. How many

were the boats upset, some entire, and some broken in pieces, on the top of people labouring to escape with gestures and actions of grief foretelling a fearful death. Others, with desperate act, took their own lives, hopeless of being able to endure such suffering; and of these, some flung themselves from lofty rocks, others strangled themselves with their own hands, other seized their own children and violently slew them at a blow; some wounded and killed themselves with their own weapons; others, falling on their knees recommended themselves to God. Ah! how many mothers wept over their drowned sons, holding them upon their knees, with arms raised spread out towards heaven and with words and various threatening gestures, upbraiding the wrath of the gods. Others with clasped hands and fingers clenched gnawed them and devoured them till they bled, crouching with their breast down on their knees in their intense and unbearable anguish. Herds of animals were to be seen, such as horses, oxen, goats and swine already environed by the waters and left isolated on the high peaks of the mountains, huddled together, those in the middle climbing to the top and treading on the others, and fighting fiercely themselves; and many would die for lack of food. Already had the birds begun to settle on men and on other animals, finding no land uncovered which was not occupied by living beings, and already had famine, the minister of death, taken the lives of the greater number of the animals, when the dead bodies, now fermented, were leaving the depth of the waters and were rising to the top. Among the buffeting waves, where they were beating one against the other, and, like as balls full of air, rebounded from the point of concussion, these found a resting place on the bodies of the dead. And above these judgements, the air was seen covered with dark clouds, riven by the forked flashes of the raging bolts of heaven, lighting up on all sides the depth of the gloom.

The motion of the air is seen by the motion of the dust thrown up by the horse's running and this motion is as swift in again filling up the vacuum left in the air which enclosed the horse, as he is rapid in passing away from the air.

Perhaps it will seem to you that you may reproach me with having represented the currents made through the air by the motion of the wind notwithstanding that the wind itself is not visible in the air. To this I must answer that it is not the motion of the wind but only the motion of the things carried along by it which is seen in the air.

THE DIVISIONS. [Footnote 76: These observations, added at the bottom of the page containing the full description of the deluge seem to indicate that it was Leonardo's intention to elaborate the subject still farther in a separate treatise.]

Darkness, wind, tempest at sea, floods of water, forests on fire, rain, bolts from heaven, earthquakes and ruins of mountains, overthrow of cities [Footnote

81: *Spianamenti di citta* (overthrow of cities). A considerable number of drawings in black chalk, at Windsor, illustrate this catastrophe. Most of them are much rubbed; one of the least injured is reproduced at Pl. XXXIX. Compare also the pen and ink sketch Pl. XXXVI.].

Whirlwinds which carry water [spouts] branches of trees, and men through the air.

Boughs stripped off by the winds, mingling by the meeting of the winds, with people upon them.

Broken trees loaded with people.

Ships broken to pieces, beaten on rocks.

Flocks of sheep. Hail stones, thunderbolts, whirlwinds.

People on trees which are unable to support them; trees and rocks, towers and hills covered with people, boats, tables, troughs, and other means of floating. Hills covered with men, women and animals; and lightning from the clouds illuminating every thing.

[Footnote: This chapter, which, with the next one, is written on a loose sheet, seems to be the passage to which one of the compilers of the Vatican copy alluded when he wrote on the margin of fol. 36: "*Qua mi ricordo della mirabile discriione del Diluuio dello autore.*" It is scarcely necessary to point out that these chapters are among those which have never before been published. The description in No. 607 may be regarded as a preliminary sketch for this one. As the MS. G. (in which it is to be found) must be attributed to the period of about 1515 we may deduce from it the approximate date of the drawings on Pl. XXXIV, XXXV, Nos. 2 and 3, XXXVI and XXXVII, since they obviously belong to this text. The drawings No. 2 on Pl. XXXV are, in the original, side by side with the text of No. 608; lines 57 to 76 are shown in the facsimile. In the drawing in Indian ink given on Pl. XXXIV we see Wind-gods in the sky, corresponding to the allusion to Aeolus in No. 607 l. 15.-Plates XXXVI and XXXVII form one sheet in the original. The texts reproduced on these Plates have however no connection with the sketches, excepting the sketches of clouds on the right hand side. These texts are given as No. 477. The group of small figures on Pl. XXXVII, to the left, seems to be intended for a '*congregatione d'uomini.*' See No. 608, l. 19.]

DESCRIPTION OF THE DELUGE.

Let there be first represented the summit of a rugged mountain with valleys

surrounding its base, and on its sides let the surface of the soil be seen to slide, together with the small roots of the bushes, denuding great portions of the surrounding rocks. And descending ruinous from these precipices in its boisterous course, let it dash along and lay bare the twisted and gnarled roots of large trees overthrowing their roots upwards; and let the mountains, as they are scoured bare, discover the profound fissures made in them by ancient earthquakes. The base of the mountains may be in great part clothed and covered with ruins of shrubs, hurled down from the sides of their lofty peaks, which will be mixed with mud, roots, boughs of trees, with all sorts of leaves thrust in with the mud and earth and stones. And into the depth of some valley may have fallen the fragments of a mountain forming a shore to the swollen waters of its river; which, having already burst its banks, will rush on in monstrous waves; and the greatest will strike upon and destroy the walls of the cities and farmhouses in the valley . Then the ruins of the high buildings in these cities will throw up a great dust, rising up in shape like smoke or wreathed clouds against the falling rain; But the swollen waters will sweep round the pool which contains them striking in eddying whirlpools against the different obstacles, and leaping into the air in muddy foam; then, falling back, the beaten water will again be dashed into the air. And the whirling waves which fly from the place of concussion, and whose impetus moves them across other eddies going in a contrary direction, after their recoil will be tossed up into the air but without dashing off from the surface. Where the water issues from the pool the spent waves will be seen spreading out towards the outlet; and there falling or pouring through the air and gaining weight and impetus they will strike on the water below piercing it and rushing furiously to reach its depth; from which being thrown back it returns to the surface of the lake, carrying up the air that was submerged with it; and this remains at the outlet in foam mingled with logs of wood and other matters lighter than water. Round these again are formed the beginnings of waves which increase the more in circumference as they acquire more movement; and this movement rises less high in proportion as they acquire a broader base and thus they are less conspicuous as they die away. But if these waves rebound from various objects they then return in direct opposition to the others following them, observing the same law of increase in their curve as they have already acquired in the movement they started with. The rain, as it falls from the clouds is of the same colour as those clouds, that is in its shaded side; unless indeed the sun's rays should break through them; in that case the rain will appear less dark than the clouds. And if the heavy masses of ruin of large mountains or of other grand buildings fall into the vast pools of water, a great quantity will be flung into the air and its movement will be in a contrary direction to that of the object which

struck the water; that is to say: The angle of reflection will be equal to the angle of incidence. Of the objects carried down by the current, those which are heaviest or rather largest in mass will keep farthest from the two opposite shores. The water in the eddies revolves more swiftly in proportion as it is nearer to their centre. The crests of the waves of the sea tumble to their bases falling with friction on the bubbles of their sides; and this friction grinds the falling water into minute particles and this being converted into a dense mist, mingles with the gale in the manner of curling smoke and wreathing clouds, and at last it, rises into the air and is converted into clouds. But the rain which falls through the atmosphere being driven and tossed by the winds becomes rarer or denser according to the rarity or density of the winds that buffet it, and thus there is generated in the atmosphere a moisture formed of the transparent particles of the rain which is near to the eye of the spectator. The waves of the sea which break on the slope of the mountains which bound it, will foam from the velocity with which they fall against these hills; in rushing back they will meet the next wave as it comes and and after a loud noise return in a great flood to the sea whence they came. Let great numbers of inhabitants — men and animals of all kinds — be seen driven by the rising of the deluge to the peaks of the mountains in the midst of the waters aforesaid.

The wave of the sea at Piombino is all foaming water. [Footnote 55. 56: These two lines are written below the bottom sketch on Pl. XXXV, 3. The MS. Leic. being written about the year 1510 or later, it does not seem to me to follow that the sketches must have been made at Piombino, where Leonardo was in the year 1502 and possibly returned there subsequently (see Vol. II. Topographical notes).]

Of the water which leaps up from the spot where great masses fall on its surface. Of the winds of Piombino at Piombino. Eddies of wind and rain with boughs and shrubs mixed in the air. Emptying the boats of the rain water.

[Footnote: The sketches on Pl. XXXV 3 stand by the side of lines 14 to 54.]

Of depicting natural phenomena (610. 611).

610.

The tremendous fury of the wind driven by the falling in of the hills on the caves within — by the falling of the hills which served as roofs to these caverns.

A stone flung through the air leaves on the eye which sees it the impression of its motion, and the same effect is produced by the drops of water which fall from the clouds when it rains.

A mountain falling on a town, will fling up dust in the form of clouds; but the colour of this dust will differ from that of the clouds. Where the rain is thickest let the colour of the dust be less conspicuous and where the dust is thickest let the rain be less conspicuous. And where the rain is mingled with the wind and with the dust the clouds created by the rain must be more transparent than those of dust [alone]. And when flames of fire are mingled with clouds of smoke and water very opaque and dark clouds will be formed [Footnote 26-28: Compare Pl. XL, 1 — the drawing in Indian ink on the left hand side, which seems to be a reminiscence of his observations of an eruption (see his remarks on Mount Etna in Vol II).]. And the rest of this subject will be treated in detail in the book on painting.

[Footnote: See the sketches and text on Pl. XXXVIII, No. 1. Lines 1-16 are there given on the left hand side, 17-30 on the right. The four lines at the bottom on the right are given as No. 472. Above these texts, which are written backwards, there are in the original sixteen lines in a larger writing from left to right, but only half of this is here visible. They treat of the physical laws of motion of air and water. It does not seem to me that there is any reason for concluding that this writing from left to right is spurious. Compare with it the facsimile of the rough copy of Leonardo's letter to Ludovico il Moro in Vol. II.]

611.

People were to be seen eagerly embarking victuals on various kinds of hastily made barks. But little of the waves were visible in those places where the dark clouds and rain were reflected.

But where the flashes caused by the bolts of heaven were reflected, there were seen as many bright spots, caused by the image of the flashes, as there were waves to reflect them to the eye of the spectator.

The number of the images produced by the flash of lightning on the waves of the water were multiplied in proportion to the distance of the spectator's eye.

So also the number of the images was diminished in proportion as they were nearer the eye which saw them [Footnote 22. 23: *Com'e provato*. See Vol. II, Nos. 874-878 and 892-901], as it has been proved in the definition of the luminosity of the moon, and of our marine horizon when the sun's rays are reflected in it and the eye which receives the reflection is remote from the sea.

VI.

THE ARTIST'S MATERIALS.

Of chalk and paper (612 — 617).

612.

To make points [crayons] for colouring dry. Temper with a little wax and do not dry it; which wax you must dissolve with water: so that when the white lead is thus tempered, the water being distilled, may go off in vapour and the wax may remain; you will thus make good crayons; but you must know that the colours must be ground with a hot stone.

613.

Chalk dissolves in wine and in vinegar or in aqua fortis and can be recombined with gum.

614.

PAPER FOR DRAWING UPON IN BLACK BY THE AID OF YOUR SPITTLE.

Take powdered gall nuts and vitriol, powder them and spread them on paper like a varnish, then write on it with a pen wetted with spittle and it will turn as black as ink.

615.

If you want to make foreshortened letters stretch the paper in a drawing frame and then draw your letters and cut them out, and make the sunbeams pass through the holes on to another stretched paper, and then fill up the angles that are wanting.

616.

This paper should be painted over with candle soot tempered with thin glue, then smear the leaf thinly with white lead in oil as is done to the letters in printing, and then print in the ordinary way. Thus the leaf will appear shaded in

the hollows and lighted on the parts in relief; which however comes out here just the contrary.

[Footnote: This text, which accompanies a facsimile impression of a leaf of sage, has already been published in the *Saggio delle Opere di L. da Vinci*, Milano 1872, p. 11. G. GOVI observes on this passage: “Forse aveva egli pensato ancora a farsi un erbario, od almeno a riprodurre facilmente su carta le forme e i particolari delle foglie di diverse piante; poiche (modificando un metodo che probabilmente gli eia stato insegnato da altri, e che piu tardi si legge ripetuto in molti ricettarii e libri di segreti), accanto a una foglia di Salvia impressa in nero su carta bianca, lascio scritto: Questa carta ...

Erano i primi tentativi di quella riproduzione immediata delle parti vegetali, che poi sotto il nome d’Impressione Naturale, fu condotta a tanta perfezione in questi ultimi tempi dal signor de Hauer e da altri.”]

617.

Very excellent will be a stiff white paper, made of the usual mixture and filtered milk of an herb called calves foot; and when this paper is prepared and damped and folded and wrapped up it may be mixed with the mixture and thus left to dry; but if you break it before it is moistened it becomes somewhat like the thin paste called *lasagne* and you may then damp it and wrap it up and put it in the mixture and leave it to dry; or again this paper may be covered with stiff transparent white and *sardonio* and then damped so that it may not form angles and then covered up with strong transparent size and as soon as it is firm cut it two fingers, and leave it to dry; again you may make stiff cardboard of *sardonio* and dry it and then place it between two sheets of papyrus and break it inside with a wooden mallet with a handle and then open it with care holding the lower sheet of paper flat and firm so that the broken pieces be not separated; then have a sheet of paper covered with hot glue and apply it on the top of all these pieces and let them stick fast; then turn it upside down and apply transparent size several times in the spaces between the pieces, each time pouring in first some black and then some stiff white and each time leaving it to dry; then smooth it and polish it.

On the preparation and use of colours (618-627).

618.

To make a fine green take green and mix it with bitumen and you will make

the shadows darker. Then, for lighter [shades] green with yellow ochre, and for still lighter green with yellow, and for the high lights pure yellow; then mix green and turmeric together and glaze every thing with it. To make a fine red take cinnabar or red chalk or burnt ochre for the dark shadows and for the lighter ones red chalk and vermilion and for the lights pure vermilion and then glaze with fine lake. To make good oil for painting. One part of oil, one of the first refining and one of the second.

619.

Use black in the shadow, and in the lights white, yellow, green, vermilion and lake. Medium shadows; take the shadow as above and mix it with the flesh tints just alluded to, adding to it a little yellow and a little green and occasionally some lake; for the shadows take green and lake for the middle shades.

[Footnote 618 and 619: If we may judge from the flourishes with which the writing is ornamented these passages must have been written in Leonardo's youth.]

620.

You can make a fine ochre by the same method as you use to make white.

621.

A FINE YELLOW.

Dissolve realgar with one part of orpiment, with aqua fortis.

WHITE.

Put the white into an earthen pot, and lay it no thicker than a string, and let it stand in the sun undisturbed for 2 days; and in the morning when the sun has dried off the night dews.

622.

To make reddish black for flesh tints take red rock crystals from Rocca Nova

or garnets and mix them a little; again armenian bole is good in part.

623.

The shadow will be burnt ,terra-verte’.

624.

THE PROPORTIONS OF COLOURS.

If one ounce of black mixed with one ounce of white gives a certain shade of darkness, what shade of darkness will be produced by 2 ounces of black to 1 ounce of white?

625.

Remix black, greenish yellow and at the end blue.

626.

Verdigris with aloes, or gall or turmeric makes a fine green and so it does with saffron or burnt orpiment; but I doubt whether in a short time they will not turn black. Ultramarine blue and glass yellow mixed together make a beautiful green for fresco, that is wall-painting. Lac and verdigris make a good shadow for blue in oil painting.

627.

Grind verdigris many times coloured with lemon juice and keep it away from yellow (?).

Of preparing the panel.

628.

TO PREPARE A PANEL FOR PAINTING ON.

The panel should be cypress or pear or service-tree or walnut. You must coat it over with mastic and turpentine twice distilled and white or, if you like, lime,

and put it in a frame so that it may expand and shrink according to its moisture and dryness. Then give it [a coat] of aqua vitae in which you have dissolved arsenic or [corrosive] sublimate, 2 or 3 times. Then apply boiled linseed oil in such a way as that it may penetrate every part, and before it is cold rub it well with a cloth to dry it. Over this apply liquid varnish and white with a stick, then wash it with urine when it is dry, and dry it again. Then pounce and outline your drawing finely and over it lay a priming of 30 parts of verdigris with one of verdigris with two of yellow.

[Footnote: M. RAVAISSON'S reading varies from mine in the following passages:

1. *opero allor [?] bo [alloro?] = "ou bien de [laurier]."*

6. *fregalo bene con un panno*. He reads *pane* for *panno* and renders it. "*Frotte le bien avec un pain de facon [jusqu'a ce] qu'il*" etc.

7. *colla stecca po laua*. He reads "*polacca*" = "*avec le couteau de bois [?] polonais [?].*"

The preparation of oils (629 — 634).

629.

OIL.

Make some oil of mustard seed; and if you wish to make it with greater ease mix the ground seeds with linseed oil and put it all under the press.

630.

TO REMOVE THE SMELL OF OIL.

Take the rank oil and put ten pints into a jar and make a mark on the jar at the height of the oil; then add to it a pint of vinegar and make it boil till the oil has sunk to the level of the mark and thus you will be certain that the oil is returned to its original quantity and the vinegar will have gone off in vapour, carrying with it the evil smell; and I believe you may do the same with nut oil or any other oil that smells badly.

631.

Since walnuts are enveloped in a thin rind, which partakes of the nature of ...,

if you do not remove it when you make the oil from them, this skin tinges the oil, and when you work with it this skin separates from the oil and rises to the surface of the painting, and this is what makes it change.

632.

TO RESTORE OIL COLOURS THAT HAVE BECOME DRY.

If you want to restore oil colours that have become dry keep them soaking in soft soap for a night and, with your finger, mix them up with the soft soap; then pour them into a cup and wash them with water, and in this way you can restore colours that have got dry. But take care that each colour has its own vessel to itself adding the colour by degrees as you restore it and mind that they are thoroughly softened, and when you wish to use them for tempera wash them five and six times with spring water, and leave them to settle; if the soft soap should be thick with any of the colours pass it through a filter. [Footnote: The same remark applies to these sections as to No. 618 and 619.]

633.

OIL.

Mustard seed pounded with linseed oil.

634.

... outside the bowl 2 fingers lower than the level of the oil, and pass it into the neck of a bottle and let it stand and thus all the oil will separate from this milky liquid; it will enter the bottle and be as clear as crystal; and grind your colours with this, and every coarse or viscid part will remain in the liquid. You must know that all the oils that have been created in seeds or fruits are quite clear by nature, and the yellow colour you see in them only comes of your not knowing how to draw it out. Fire or heat by its nature has the power to make them acquire colour. See for example the exudation or gums of trees which partake of the nature of rosin; in a short time they harden because there is more heat in them than in oil; and after some time they acquire a certain yellow hue tending to black. But oil, not having so much heat does not do so; although it hardens to some extent into sediment it becomes finer. The change in oil which

occurs in painting proceeds from a certain fungus of the nature of a husk which exists in the skin which covers the nut, and this being crushed along with the nuts and being of a nature much resembling oil mixes with it; it is of so subtle a nature that it combines with all colours and then comes to the surface, and this it is which makes them change. And if you want the oil to be good and not to thicken, put into it a little camphor melted over a slow fire and mix it well with the oil and it will never harden.

[Footnote: The same remark applies to these sections as to No. 618 and 619.]

On varnishes [or powders] (635-637).

635.

VARNISH [OR POWDER].

Take cypress [oil] and distil it and have a large pitcher, and put in the extract with so much water as may make it appear like amber, and cover it tightly so that none may evaporate. And when it is dissolved you may add in your pitcher as much of the said solution, as shall make it liquid to your taste. And you must know that amber is the gum of the cypress-tree.

VARNISH [OR POWDER].

And since varnish [powder] is the resin of juniper, if you distil juniper you can dissolve the said varnish [powder] in the essence, as explained above.

636.

VARNISH [OR POWDER].

Notch a juniper tree and give it water at the roots, mix the liquor which exudes with nut-oil and you will have a perfect varnish [powder], made like amber varnish [powder], fine and of the best quality make it in May or April.

637.

VARNISH [OR POWDER].

Mercury with Jupiter and Venus, — a paste made of these must be corrected by

the mould (?) continuously, until Mercury separates itself entirely from Jupiter and Venus. [Footnote: Here, and in No. 641 *Mercurio* seems to mean quicksilver, *Giove* stands for iron, *Venere* for copper and *Saturno* for lead.]

On chemical materials (638-650).

638.

Note how aqua vitae absorbs into itself all the colours and smells of flowers. If you want to make blue put iris flowers into it and for red solanum berries (?) 639.

Salt may be made from human excrement burnt and calcined and made into lees, and dried by a slow fire, and all dung in like manner yields salt, and these salts when distilled are very pungent.

640.

Sea water filtered through mud or clay, leaves all its saltiness in it. Woollen stuffs placed on board ship absorb fresh water. If sea water is distilled under a retort it becomes of the first excellence and any one who has a little stove in his kitchen can, with the same wood as he cooks with, distil a great quantity of water if the retort is a large one.

641.

MOULD(?).

The mould (?) may be of Venus, or of Jupiter and Saturn and placed frequently in the fire. And it should be worked with fine emery and the mould (?) should be of Venus and Jupiter impasted over (?) Venus. But first you will test Venus and Mercury mixed with Jove, and take means to cause Mercury to disperse; and then fold them well together so that Venus or Jupiter be connected as thinly as possible.

[Footnote: See the note to 637.]

642.

Nitre, vitriol, cinnabar, alum, salt ammoniac, sublimated mercury, rock salt, alcali salt, common salt, rock alum, alum schist (?), arsenic, sublimate, realgar, tartar, orpiment, verdegris.

643.

Pitch four ounces virgin wax, four ounces incense, two ounces oil of roses one ounce.

644.

Four ounces virgin wax, four ounces Greek pitch, two ounces incense, one ounce oil of roses, first melt the wax and oil then the Greek pitch then the other things in powder.

645.

Very thin glass may be cut with scissors and when placed over inlaid work of bone, gilt, or stained of other colours you can saw it through together with the bone and then put it together and it will retain a lustre that will not be scratched nor worn away by rubbing with the hand.

646.

TO DILUTE WHITE WINE AND MAKE IT PURPLE.

Powder gall nuts and let this stand 8 days in the white wine; and in the same way dissolve vitriol in water, and let the water stand and settle very clear, and the wine likewise, each by itself, and strain them well; and when you dilute the white wine with the water the wine will become red.

647.

Put marcasite into aqua fortis and if it turns green, know that it has copper in it. Take it out with saltpetre and soft soap.

648.

A white horse may have the spots removed with the Spanish haematite or with aqua fortis or with ... Removes the black hair on a white horse with the singeing iron. Force him to the ground.

FIRE.

If you want to make a fire which will set a hall in a blaze without injury do this: first perfume the hall with a dense smoke of incense or some other odoriferous substance: It is a good trick to play. Or boil ten pounds of brandy to evaporate, but see that the hall is completely closed and throw up some powdered varnish among the fumes and this powder will be supported by the smoke; then go into the room suddenly with a lighted torch and at once it will be in a blaze.

FIRE.

Take away that yellow surface which covers oranges and distill them in an alembic, until the distillation may be said to be perfect.

FIRE.

Close a room tightly and have a brasier of brass or iron with fire in it and sprinkle on it two pints of aqua vitae, a little at a time, so that it may be converted into smoke. Then make some one come in with a light and suddenly you will see the room in a blaze like a flash of lightning, and it will do no harm to any one.

VII.**PHILOSOPHY AND HISTORY OF THE ART OF PAINTING.**

The relation of art and nature (651. 652).

What is fair in men, passes away, but not so in art.

HE WHO DESPISES PAINTING LOVES NEITHER PHILOSOPHY NOR NATURE.

If you condemn painting, which is the only imitator of all visible works of nature, you will certainly despise a subtle invention which brings philosophy and subtle speculation to the consideration of the nature of all forms — seas and plains, trees, animals, plants and flowers — which are surrounded by shade and light. And this is true knowledge and the legitimate issue of nature; for painting is born of nature — or, to speak more correctly, we will say it is the grandchild of nature; for all visible things are produced by nature, and these her children have given birth to painting. Hence we may justly call it the grandchild of nature and related to God.

Painting is superior to poetry (653. 654).

653.

THAT PAINTING SURPASSES ALL HUMAN WORKS BY THE SUBTLE CONSIDERATIONS BELONGING TO IT.

The eye, which is called the window of the soul, is the principal means by which the central sense can most completely and abundantly appreciate the infinite works of nature; and the ear is the second, which acquires dignity by hearing of the things the eye has seen. If you, historians, or poets, or mathematicians had not seen things with your eyes you could not report of them in writing. And if you, O poet, tell a story with your pen, the painter with his brush can tell it more easily, with simpler completeness and less tedious to be understood. And if you call painting dumb poetry, the painter may call poetry blind painting. Now which is the worse defect? to be blind or dumb? Though the poet is as free as the painter in the invention of his fictions they are not so satisfactory to men as paintings; for, though poetry is able to describe forms, actions and places in words, the painter deals with the actual similitude of the forms, in order to represent them. Now tell me which is the nearer to the actual man: the name of man or the image of the man. The name of man differs in different countries, but his form is never changed but by death.

654.

And if the poet gratifies the sense by means of the ear, the painter does so by the eye — the worthier sense; but I will say no more of this but that, if a good painter represents the fury of a battle, and if a poet describes one, and they are both together put before the public, you will see where most of the spectators will stop, to which they will pay most attention, on which they will bestow most praise, and which will satisfy them best. Undoubtedly painting being by a long way the more intelligible and beautiful, will please most. Write up the name of God [Christ] in some spot and setup His image opposite and you will see which will be most revered. Painting comprehends in itself all the forms of nature, while you have nothing but words, which are not universal as form is, and if you have the effects of the representation, we have the representation of the effects. Take a poet who describes the beauty of a lady to her lover and a painter who represents her and you will see to which nature guides the enamoured critic. Certainly the proof should be allowed to rest on the verdict of experience. You have ranked painting among the mechanical arts but, in truth, if painters were as apt at praising their own works in writing as you are, it would not lie under the stigma of so base a name. If you call it mechanical because it is, in the first place, manual, and that it is the hand which produces what is to be found in the imagination, you too writers, who set down manually with the pen what is devised in your mind. And if you say it is mechanical because it is done for money, who falls into this error — if error it can be called — more than you? If you lecture in the schools do you not go to whoever pays you most? Do you do any work without pay? Still, I do not say this as blaming such views, for every form of labour looks for its reward. And if a poet should say: “I will invent a fiction with a great purpose,” the painter can do the same, as Apelles painted Calumny. If you were to say that poetry is more eternal, I say the works of a coppersmith are more eternal still, for time preserves them longer than your works or ours; nevertheless they have not much imagination . And a picture, if painted on copper with enamel colours may be yet more permanent. We, by our arts may be called the grandsons of God. If poetry deals with moral philosophy, painting deals with natural philosophy. Poetry describes the action of the mind, painting considers what the mind may effect by the motions [of the body]. If poetry can terrify people by hideous fictions, painting can do as much by depicting the same things in action. Supposing that a poet applies himself to represent beauty, ferocity, or a base, a foul or a monstrous thing, as against a painter, he may in his ways bring forth a variety of forms; but will the painter not satisfy more? are there not pictures to be seen, so like the actual things, that

they deceive men and animals?

Painting is superior to sculpture (655. 656).

655.

THAT SCULPTURE IS LESS INTELLECTUAL THAN PAINTING, AND LACKS MANY CHARACTERISTICS OF NATURE.

I myself, having exercised myself no less in sculpture than in painting and doing both one and the other in the same degree, it seems to me that I can, without invidiousness, pronounce an opinion as to which of the two is of the greatest merit and difficulty and perfection. In the first place sculpture requires a certain light, that is from above, a picture carries everywhere with it its own light and shade. Thus sculpture owes its importance to light and shade, and the sculptor is aided in this by the nature, of the relief which is inherent in it, while the painter whose art expresses the accidental aspects of nature, places his effects in the spots where nature must necessarily produce them. The sculptor cannot diversify his work by the various natural colours of objects; painting is not defective in any particular. The sculptor when he uses perspective cannot make it in any way appear true; that of the painter can appear like a hundred miles beyond the picture itself. Their works have no aerial perspective whatever, they cannot represent transparent bodies, they cannot represent luminous bodies, nor reflected lights, nor lustrous bodies — as mirrors and the like polished surfaces, nor mists, nor dark skies, nor an infinite number of things which need not be told for fear of tedium. As regards the power of resisting time, though they have this resistance [Footnote 19: From what is here said as to painting on copper it is very evident that Leonardo was not acquainted with the method of painting in oil on thin copper plates, introduced by the Flemish painters of the XVIIth century. J. LERMOLIEFF has already pointed out that in the various collections containing pictures by the great masters of the Italian Renaissance, those painted on copper (for instance the famous reading Magdalen in the Dresden Gallery) are the works of a much later date (see *Zeitschrift für bildende Kunst*. Vol. X pg. 333, and: *Werke italienischer Master in den Galerien von Munchen, Dresden und Berlin*. Leipzig 1880, pg. 158 and 159.) — Compare No. 654, 29.], a picture painted on thick copper covered with white enamel on which it is painted with enamel colours and then put into the fire again and baked, far exceeds sculpture

in permanence. It may be said that if a mistake is made it is not easy to remedy it; it is but a poor argument to try to prove that a work be the nobler because oversights are irremediable; I should rather say that it will be more difficult to improve the mind of the master who makes such mistakes than to repair the work he has spoilt.

656.

We know very well that a really experienced and good painter will not make such mistakes; on the contrary, with sound rules he will remove so little at a time that he will bring his work to a good issue. Again the sculptor if working in clay or wax, can add or reduce, and when his model is finished it can easily be cast in bronze, and this is the last operation and is the most permanent form of sculpture. Inasmuch as that which is merely of marble is liable to ruin, but not bronze. Hence a painting done on copper which as I said of painting may be added to or altered, resembles sculpture in bronze, which, having first been made in wax could then be altered or added to; and if sculpture in bronze is durable, this work in copper and enamel is absolutely imperishable. Bronze is but dark and rough after all, but this latter is covered with various and lovely colours in infinite variety, as has been said above; or if you will have me only speak of painting on panel, I am content to pronounce between it and sculpture; saying that painting is the more beautiful and the more imaginative and the more copious, while sculpture is the more durable but it has nothing else. Sculpture shows with little labour what in painting appears a miraculous thing to do; to make what is impalpable appear palpable, flat objects appear in relief, distant objects seem close. In fact painting is adorned with infinite possibilities which sculpture cannot command.

Aphorisms (657-659).

657.

OF PAINTING.

Men and words are ready made, and you, O Painter, if you do not know how to make your figures move, are like an orator who knows not how to use his words.

658.

As soon as the poet ceases to represent in words what exists in nature, he in fact ceases to resemble the painter; for if the poet, leaving such representation, proceeds to describe the flowery and flattering speech of the figure, which he wishes to make the speaker, he then is an orator and no longer a poet nor a painter. And if he speaks of the heavens he becomes an astrologer, and philosopher; and a theologian, if he discourses of nature or God. But, if he restricts himself to the description of objects, he would enter the lists against the painter, if with words he could satisfy the eye as the painter does.

659.

Though you may be able to tell or write the exact description of forms, the painter can so depict them that they will appear alive, with the shadow and light which show the expression of a face; which you cannot accomplish with the pen though it can be achieved by the brush.

On the history of painting (660. 661).

660.

THAT PAINTING DECLINES AND DETERIORATES FROM AGE TO AGE, WHEN PAINTERS HAVE NO OTHER STANDARD THAN PAINTING ALREADY DONE.

Hence the painter will produce pictures of small merit if he takes for his standard the pictures of others. But if he will study from natural objects he will bear good fruit; as was seen in the painters after the Romans who always imitated each other and so their art constantly declined from age to age. After these came Giotto the Florentine who — not content with imitating the works of Cimabue his master — being born in the mountains and in a solitude inhabited only by goats and such beasts, and being guided by nature to his art, began by drawing on the rocks the movements of the goats of which he was keeper. And thus he began to draw all the animals which were to be found in the country, and in such wise that after much study he excelled not only all the masters of his time but all those of many bygone ages. Afterwards this art declined again, because everyone imitated the pictures that were already done; thus it went on from century to century until Tomaso, of Florence, nicknamed Masaccio, showed by

his perfect works how those who take for their standard any one but nature — the mistress of all masters — weary themselves in vain. And, I would say about these mathematical studies that those who only study the authorities and not the works of nature are descendants but not sons of nature the mistress of all good authors. Oh! how great is the folly of those who blame those who learn from nature [Footnote 22: *lasciando stare li autori*. In this observation we may detect an indirect evidence that Leonardo regarded his knowledge of natural history as derived from his own investigations, as well as his theories of perspective and optics. Compare what he says in praise of experience (Vol II; XIX).], setting aside those authorities who themselves were the disciples of nature.

661.

That the first drawing was a simple line drawn round the shadow of a man cast by the sun on a wall.

The painter's scope.

662.

The painter strives and competes with nature.

X. STUDIES AND SKETCHES FOR PICTURES AND DECORATIONS.

An artist's manuscript notes can hardly be expected to contain any thing more than incidental references to those masterpieces of his work of which the fame, sounded in the writings of his contemporaries, has left a glorious echo to posterity. We need not therefore be surprised to find that the texts here reproduced do not afford us such comprehensive information as we could wish. On the other hand, the sketches and studies prepared by Leonardo for the two grandest compositions he ever executed: The Fresco of the Last Supper in the Refectory of Santa Maria delle Grazie at Milan, and the Cartoon of the Battle of Anghiari, for the Palazzo della Signoria at Florence — have been preserved; and, though far from complete, are so much more numerous than the manuscript notes, that we are justified in asserting that in value and interest they amply compensate for the meagerness of the written suggestions.

The notes for the composition of the Last Supper, which are given under nos. 665 and 666 occur in a MS. at South Kensington, II2, written in the years 1494-1495. *This MS. sketch was noted down not more than three or four years before the painting was executed, which justifies the inference that at the time when it was written the painter had not made up his mind definitely even as to the general scheme of the work; and from this we may also conclude that the drawings of apostles' heads at Windsor, in red chalk, must be ascribed to a later date. They are studies for the head of St. Matthew, the fourth figure on Christ's left hand — see Pl. XL VII, the sketch (in black chalk) for the head of St. Philip, the third figure on the left hand — see Pl. XL VIII, for St. Peter's right arm — see Pl. XLIX, and for the expressive head of Judas which has unfortunately somewhat suffered by subsequent restoration of outlines, — see Pl. L. According to a tradition, as unfounded as it is improbable, Leonardo made use of the head of Padre Bandelli, the prior of the convent, as the prototype of his Judas; this however has already been contradicted by Amoretti "Memorie storiche" cap. XIV. The study of the head of a criminal on Pl. LI has, it seems to me, a better claim to be regarded as one of the preparatory sketches for the head of Judas. The Windsor collection contains two old copies of the head of St. Simon, the figure to the extreme left of Christ, both of about equal merit (they are marked as*

Nos. 21 and 36) — the second was reproduced on Pl. VIII of the Grosvenor Gallery Publication in 1878. *There is also at Windsor a drawing in black chalk of folded hands (marked with the old No. 212; No. LXI of the Grosvenor Gallery Publication) which I believe to be a copy of the hands of St. John, by some unknown pupil.* A reproduction of the excellent drawings of heads of Apostles in the possession of H. R. H. the Grand Duchess of Weimar would have been out of my province in this work, and, with regard to them, I must confine myself to pointing out that the difference in style does not allow of our placing the Weimar drawings in the same category as those here reproduced. The mode of grouping in the Weimar drawings is of itself sufficient to indicate that they were not executed before the picture was painted, but, on the contrary, afterwards, and it is, on the face of it, incredible that so great a master should thus have copied from his own work.

The drawing of Christ's head, in the Brera palace at Milan was perhaps originally the work of Leonardo's hand; it has unfortunately been entirely retouched and re-drawn, so that no decisive opinion can be formed as to its genuineness.

The red chalk drawing reproduced on Pl. XLVI is in the Accademia at Venice; it was probably made before the text, Nos. 664 and 665, was written.

The two pen and ink sketches on Pl. XLV seem to belong to an even earlier date; the more finished drawing of the two, on the right hand, represents Christ with only St. John and Judas and a third disciple whose action is precisely that described in No. 666, Pl. 4. *It is hardly necessary to observe that the other sketches on this page and the lines of text below the circle (containing the solution of a geometrical problem) have no reference to the picture of the Last Supper. With this figure of Christ may be compared a similar pen and ink drawing reproduced on page 297 below on the left hand; the original is in the Louvre. On this page again the rest of the sketches have no direct bearing on the composition of the Last Supper, not even, as it seems to me, the group of four men at the bottom to the right hand — who are listening to a fifth, in their midst addressing them. Moreover the writing on this page (an explanation of a disk shaped instrument) is certainly not in the same style as we find constantly used by Leonardo after the year 1489.*

It may be incidentally remarked that no sketches are known for the portrait of "Mona Lisa", nor do the MS. notes ever allude to it, though according to Vasari the master had it in hand for fully four years.

Leonardo's cartoon for the picture of the battle of Anghiari has shared the fate of the rival work, Michaelangelo's "Bathers summoned to Battle". Both have been lost in some wholly inexplicable manner. I cannot here enter into the

remarkable history of this work; I can only give an account of what has been preserved to us of Leonardo's scheme and preparations for executing it. The extent of the material in studies and drawings was till now quite unknown. Their publication here may give some adequate idea of the grandeur of this famous work. The text given as No. 669 contains a description of the particulars of the battle, but for the reasons given in the note to this text, I must abandon the idea of taking this passage as the basis of my attempt to reconstruct the picture as the artist conceived and executed it.

I may here remind the reader that Leonardo prepared the cartoon in the Sala del Papa of Santa Maria Novella at Florence and worked there from the end of October 1503 till February 1504, and then was busied with the painting in the Sala del Consiglio in the Palazzo della Signoria, till the work was interrupted at the end of May 1506. (See Milanese's note to Vasari pp. 43 — 45 Vol. IV ed. 1880.) Vasari, as is well known, describes only one scene or episode of the cartoon — the Battle for the Standard in the foreground of the composition, as it would seem; and this only was ever finished as a mural decoration in the Sala del Consiglio. This portion of the composition is familiar to all from the disfigured copy engraved by Edelinck. Mariette had already very acutely observed that Edelinck must surely have worked from a Flemish copy of the picture. There is in the Louvre a drawing by Rubens (No. 565) which also represents four horsemen fighting round a standard and which agrees with Edelinck's engraving, but the engraving reverses the drawing. An earlier Flemish drawing, such as may have served as the model for both Rubens and Edelinck, is in the Uffizi collection (see Philpots's Photograph, No. 732). It seems to be a work of the second half of the XVIth century, a time when both the picture and the cartoon had already been destroyed. It is apparently the production of a not very skilled hand. Raphael Trichet du Fresne, 1651, mentions that a small picture by Leonardo himself of the Battle of the Standard was then extant in the Tuileries; by this he probably means the painting on panel which is now in the possession of Madame Timbal in Paris, and which has lately been engraved by Haussoullier as a work by Leonardo. The picture, which is very carefully painted, seems to me however to be the work of some unknown Florentine painter, and probably executed within the first ten years of the XVIth century. At the same time, it would seem to be a copy not from Leonardo's cartoon, but from his picture in the Palazzo della Signoria; at any rate this little picture, and the small Flemish drawing in Florence are the oldest finished copies of this episode in the great composition of the Battle of Anghiari.

In his *Life of Raphael*, Vasari tells us that Raphael copied certain works of Leonardo's during his stay in Florence. Raphael's first visit to Florence lasted

from the middle of October 1504 till July 1505, and he revisited it in the summer of 1506. The hasty sketch, now in the possession of the University of Oxford and reproduced on page 337 also represents the Battle of the Standard and seems to have been made during his first stay, and therefore not from the fresco but from the cartoon; for, on the same sheet we also find, besides an old man's head drawn in Leonardo's style, some studies for the figure of St. John the Martyr which Raphael used in 1505 in his great fresco in the Church of San Severo at Perugia.

Of Leonardo's studies for the Battle of Anghiari I must in the first place point to five, on three of which — Pl. LII 2, Pl. LIII, Pl. LVI — we find studies for the episode of the Standard. The standard bearer, who, in the above named copies is seen stooping, holding on to the staff across his shoulder, is immediately recognisable as the left-hand figure in Raphael's sketch, and we find it in a similar attitude in Leonardo's pen and ink drawing in the British Museum — Pl. LII, 2 — the lower figure to the right. It is not difficult to identify the same figure in two more complicated groups in the pen and ink drawings, now in the Accademia at Venice — Pl. LIII, and Pl. LIV — where we also find some studies of foot soldiers fighting. On the sheet in the British Museum — Pl. LII, 2 — we find, among others, one group of three horses galloping forwards: one horseman is thrown and protects himself with his buckler against the lance thrusts of two others on horseback, who try to pierce him as they ride past. The same action is repeated, with some variation, in two sketches in pen and ink on a third sheet, in the Accademia at Venice, Pl. LV; a coincidence which suggests the probability of such an incident having actually been represented on the cartoon. We are not, it is true, in a position to declare with any certainty which of these three dissimilar sketches may have been the nearest to the group finally adopted in executing the cartoon.

With regard, however, to one of the groups of horsemen it is possible to determine with perfect certainty not only which arrangement was preferred, but the position it occupied in the composition. The group of horsemen on Pl. LVII is a drawing in black chalk at Windsor, which is there attributed to Leonardo, but which appears to me to be the work of Cesare da Sesto, and the Commendatore Giov. Morelli supports me in this view. It can hardly be doubted that da Sesto, as a pupil of Leonardo's, made this drawing from his master's cartoon, if we compare it with the copy made by Raphael — here reproduced, for just above the fighting horseman in Raphael's copy it is possible to detect a horse which is seen from behind, going at a slower pace, with his tail flying out to the right and the same horse may be seen in the very same attitude carrying a dimly sketched rider, in the foreground of Cesare da Sesto's drawing.

If a very much rubbed drawing in black chalk at Windsor — Pl. LVI — is, as it appears to be, the reversed impression of an original drawing, it is not difficult to supplement from it the portions drawn by Cesare da Sesto. Nay, it may prove possible to reconstruct the whole of the lost cartoon from the mass of materials we now have at hand which we may regard as the nucleus of the composition. A large pen and ink drawing by Raphael in the Dresden collection, representing three horsemen fighting, and another, by Cesare da Sesto, in the Uffizi, of light horsemen fighting are a further contribution which will help us to reconstruct it.

The sketch reproduced on Pl. LV gives a suggestive example of the way in which foot-soldiers may have been introduced into the cartoon as fighting among the groups of horsemen; and I may here take the opportunity of mentioning that, for reasons which it would be out of place to enlarge upon here, I believe the two genuine drawings by Raphael's hand in his "Venetian sketch-book" as it is called — one of a standard bearer marching towards the left, and one of two foot-soldiers armed with spears and fighting with a horseman — to be undoubtedly copies from the cartoon of the Battle of Anghiari.

Leonardo's two drawings, preserved in the museum at Buda-Pesth and reproduced on pages 338 and 339 are preliminary studies for the heads of fighting warriors. The two heads drawn in black chalk (pg. 338) and the one seen in profile, turned to the left, drawn in red chalk (pg. 339), correspond exactly with those of two horsemen in the scene of the fight round the standard as we see them in Madame Timbal's picture and in the other finished copies. An old copy of the last named drawing by a pupil of Leonardo is in MS. C. A. 187b; 561b (See Saggio, Tav. XXII). Leonardo used to make such finished studies of heads as those, drawn on detached sheets, before beginning his pictures from his drawings — compare the preparatory studies for the fresco of the Last Supper, given on Pl. XLVII and Pl. L. Other drawings of heads, all characterised by the expression of vehement excitement that is appropriate to men fighting, are to be seen at Windsor (No. 44) and at the Accademia at Venice (IV, 13); at the back of one of the drawings at Buda-Pesth there is the bust of a warrior carrying a spear on his left shoulder, holding up the left arm (See Csatakepek a XVI — lk Szazadbol osszeallitotta Pvlsky Karoly). These drawings may have been made for other portions of the cartoon, of which no copies exist, and thus we are unable to identify these preparatory drawings. Finally I may add that a sketch of fighting horse and foot soldiers, formerly in the possession of M. Thiers and published by Charles Blanc in his "Vies des Peintres" can hardly be accepted as genuine. It is not to be found, as I am informed, among the late President's property, and no one appears to know where it now is.

An attempted reconstruction of the Cartoon, which is not only unsuccessful

but perfectly unfounded, is to be seen in the lithograph by Bergeret, published in Charles Blanc's "Vies des peintres" and reprinted in "The great Artists. L. da Vinci", p. 80. This misleading pasticcio may now be rejected without hesitation.

There are yet a few original drawings by Leonardo which might be mentioned here as possibly belonging to the cartoon of the Battle; such as the pen and ink sketches on Pl. XXI and on Pl. XXXVIII, No. 3, but we should risk too wide a departure from the domain of ascertained fact.

With regard to the colours and other materials used by Leonardo the reader may be referred to the quotations from the accounts for the picture in question given by Milanesi in his edition of Vasari (Vol. IV, p. 44, note) where we find entries of a similar character to those in Leonardo's note books for the year 1505; S. K. M. 12 (see No. 636).

That Leonardo was employed in designing decorations and other preparations for high festivals, particularly for the court of Milan, we learn not only from the writings of his contemporaries but from his own incidental allusions; for instance in MS. C. 15b (1), l. 9. In the arrangement of the texts referring to this I have placed those first, in which historical personages are named — Nos. 670-674. Among the descriptions of Allegorical subjects two texts lately found at Oxford have been included, Nos. 676 and 677. They are particularly interesting because they are accompanied by large sketches which render the meaning of the texts perfectly clear. It is very intelligible that in other cases, where there are no illustrative sketches, the notes must necessarily remain obscure or admit of various interpretations. The literature of the time affords ample evidence of the use of such allegorical representations, particularly during the Carnival and in Leonardo's notes we find the Carnival expressly mentioned — Nos. 685 and 704. Vasari in his Life of Pontormo, particularly describes that artist's various undertakings for Carnival festivities. These very graphic descriptions appear to me to throw great light in more ways than one on the meaning of Leonardo's various notes as to allegorical representations and also on mottoes and emblems — Nos. 681-702. In passing judgment on the allegorical sketches and emblems it must not be overlooked that even as pictures they were always accompanied by explanations in words. Several finished drawings of allegorical compositions or figures have been preserved, but as they have no corresponding explanation in the MSS. they had no claim to be reproduced here. The female figure on Pl. XXVI may perhaps be regarded as a study for such an allegorical painting, of which the purport would have been explained by an inscription.

On Madonna pictures.

663.

[In the autumn of] 1478 I began the two Madonna [pictures].

[Footnote: Photographs of this page have been published by BRAUN, No. 439, and PHILPOT, No. 718.

1. *Incominciai*. We have no other information as to the two pictures of the Madonna here spoken of. As Leonardo here tells us that he had begun two Madonnas at the same time, the word '*incominciai*' may be understood to mean that he had begun at the same time preparatory studies for two pictures to be painted later. If this is so, the non-existence of the pictures may be explained by supposing that they were only planned and never executed. I may here mention a few studies for pictures of the Madonna which probably belong to this early time; particularly a drawing in silver-point on bluish tinted paper at Windsor — see Pl. XL, No. 3 — , a drawing of which the details have almost disappeared in the original but have been rendered quite distinct in the reproduction; secondly a slight pen and ink sketch in, the Codex VALLARDI, in the Louvre, fol. 64, No. 2316; again a silver point drawing of a Virgin and child drawn over again with the pen in the His de la Salle collection also in the Louvre, No. 101. (See Vicomte BOTH DE TAUZIA, *Notice des dessins de la collection His de la Salle, exposes au Louvre*. Paris 1881, pp. 80, 81.) This drawing is, it is true, traditionally ascribed to Raphael, but the author of the catalogue very justly points out its great resemblance with the sketches for Madonnas in the British Museum which are indisputably Leonardo's. Some of these have been published by Mr. HENRY WALLIS in the Art Journal, New Ser. No. 14, Feb. 1882. If the non-existence of the two pictures here alluded to justifies my hypothesis that only studies for such pictures are meant by the text, it may also be supposed that the drawings were made for some comrade in VERROCCHIO'S atelier. (See VASARI, Sansoni's ed. Florence 1880. Vol. IV, p. 564): "*E perche a Lorenzo piaceva fuor di modo la maniera di Lionardo, la seppe cosi bene imitare, che niuno fu che nella pulitezza e nel finir l'opere con diligenza l'imitasse più di lui.*" Leonardo's notes give me no opportunity of discussing the pictures executed by him in Florence, before he moved to Milan. So the studies for the unfinished picture of the Adoration of the Magi — in the Uffizi, Florence — cannot be described here, nor would any discussion about the picture in the Louvre "*La Vierge aux Rochers*" be appropriate in the absence of all allusion to it in the MSS. Therefore, when I presently add a few remarks on this painting in explanation of the Master's drawings for it, it will be not merely with a view to facilitate critical researches about the picture now in the National Gallery,

London, which by some critics has been pronounced to be a replica of the Louvre picture, but also because I take this opportunity of publishing several finished studies of the Master's which, even if they were not made in Florence but later in Milan, must have been prior to the painting of the Last Supper. The original picture in Paris is at present so disfigured by dust and varnish that the current reproductions in photography actually give evidence more of the injuries to which the picture has been exposed than of the original work itself. The wood-cut given on p. 344, is only intended to give a general notion of the composition. It must be understood that the outline and expression of the heads, which in the picture is obscured but not destroyed, is here altogether missed. The facsimiles which follow are from drawings which appear to me to be studies for "*La Vierge aux Rochers*."

1. A drawing in silver point on brown toned paper of a woman's head looking to the left. In the Royal Library at Turin, apparently a study from nature for the Angel's head (Pl. XLII).

2. A study of drapery for the left leg of the same figure, done with the brush, Indian ink on greenish paper, the lights heightened with white.

The original is at Windsor, No. 223. The reproduction Pl. XLIII is defective in the shadow on the upper part of the thigh, which is not so deep as in the original; it should also be observed that the folds of the drapery near the hips are somewhat altered in the finished work in the Louvre, while the London copy shows a greater resemblance to this study in that particular.

3. A study in red chalk for the bust of the Infant Christ — No. 3 in the Windsor collection (Pl. XLIV). The well-known silver-point drawing on pale green paper, in the Louvre, of a boy's head (No. 363 in REISET, *Notice des dessins, Ecoles d'Italie*) seems to me to be a slightly altered copy, either from the original picture or from this red chalk study.

4. A silver-point study on greenish paper, for the head of John the Baptist, reproduced on p. 342. This was formerly in the Codex Vallardi and is now exhibited among the drawings in the Louvre. The lights are, in the original, heightened with white; the outlines, particularly round the head and ear, are visibly restored.

There is a study of an outstretched hand — No. 288 in the Windsor collection — which was published in the Grosvenor Gallery Publication, 1878, simply under the title of: "No. 72 Study of a hand, pointing" which, on the other hand, I regard as a copy by a pupil. The action occurs in the kneeling angel of the Paris picture and not in the London copy.

These four genuine studies form, I believe, a valuable substitute in the absence of any MS. notes referring to the celebrated Paris picture.]

664.

A tan-coloured small cap, A doublet of black serge, A black jerkin lined A blue coat lined, with fur of foxes' breasts, and the collar of the jerkin covered with black and white stippled velvet Bernardo di Bandino Baroncelli; black hose.

[Footnote: These eleven lines of text are by the side of the pen and ink drawing of a man hanged — Pl. LXII, No. 1. This drawing was exhibited in 1879 at the *Ecole des Beaux-Arts* in Paris and the compilers of the catalogue amused themselves by giving the victim's name as follows: "*Un pendu, vetu d'une longue robe, les mains liées sur le dos ... Bernardo di Bendino Barontigni, marchand de pantalons*" (see *Catalogue descriptif des Dessins de Mailres anciens exposes a l'Ecole des Beaux Arts*, Paris 1879; No. 83, pp. 9-10). Now, the criminal represented here, is none other than Bernardino di Bandino Baroncelli the murderer of Giuliano de'Medici, whose name as a coadjutor in the conspiracy of the Pazzi has gained a melancholy notoriety by the tragedy of the 26th April 1478. Bernardo was descended from an ancient family and the son of the man who, under King Ferrante, was President of the High Court of Justice in Naples. His ruined fortunes, it would seem, induced him to join the Pazzi; he and Francesco Pazzi were entrusted with the task of murdering Giuliano de'Medici on the fixed day. Their victim not appearing in the cathedral at the hour when they expected him, the two conspirators ran to the palace of the Medici and induced him to accompany them. Giuliano then took his place in the chancel of the Cathedral, and as the officiating priest raised the Host — the sign agreed upon — Bernardo stabbed the unsuspecting Giuliano in the breast with a short sword; Giuliano stepped backwards and fell dead. The attempt on Lorenzo's life however, by the other conspirators at the same moment, failed of success. Bernardo no sooner saw that Lorenzo tried to make his escape towards the sacristy, than he rushed upon him, and struck down Francesco Nori who endeavoured to protect Lorenzo. How Lorenzo then took refuge behind the brazen doors of the sacristy, and how, as soon as Giuliano's death was made known, the further plans of the conspirators were defeated, while a terrible vengeance overtook all the perpetrators and accomplices, this is no place to tell. Bernardo Bandini alone seemed to be favoured by fortune; he hid first in the tower of the Cathedral, and then escaped undiscovered from Florence. Poliziano, who was with Lorenzo in the Cathedral, says in his 'Conjuratōnis Pactianae

Commentarium': "*Bandinus fugitans in Tiphernatem incidit, a quo in aciem receptus Senas pervenit.*" And Gino Capponi in summing up the reports of the numerous contemporary narrators of the event, says: "*Bernardo Bandini ricoverato in Costantinopoli, fu per ordine del Sultano preso e consegnato a un Antonio di Bernardino dei Medici, che Lorenzo aveva mandato apposta in Turchia: così era grande la potenza di quest' uomo e grande la voglia di farne mostra e che non restasse in vita chi aveagli ucciso il fratello, fu egli applicato appena giunto*" (*Storia della Repubblica di Firenze II*, 377, 378). Details about the dates may be found in the *Chronichetta di Belfredello Strinati Alfieri*: "*Bernardo di Bandino Bandini sopradetto ne venne preso da Gostantinopoti a dì 14. Dicembre 1479 e disaminato, che fu al Bargello, fu impiccato alle finestre di detto Bargello allato alla Doana a dì 29. Dicembre MCCCCLXXIX che pochi dì stette.*" It may however be mentioned with reference to the mode of writing the name of the assassin that, though most of his contemporaries wrote Bernardo Bandini, in the *Breve Chronicon Caroli Petri de Joanninis* he is called Bernardo di Bandini Baroncelli; and, in the *Sententiae Domini Matthaei de Toscana*, Bernardus Joannis Bandini de Baroncellis, as is written on Leonardo's drawing of him when hanged. Now VASARI, in the life of *Andrea del Castagno* (Vol. II, 680; ed. Milanese 1878), tells us that in 1478 this painter was commissioned by order of the Signoria to represent the members of the Pazzi conspiracy as traitors, on the facade of the Palazzo del Podestà — the Bargello. This statement is obviously founded on a mistake, for Andrea del Castagno was already dead in 1457. He had however been commissioned to paint Rinaldo degli Albizzi, when declared a rebel and exiled in 1434, and his adherents, as hanging head downwards; and in consequence he had acquired the nickname of Andrea degl' Impiccati. On the 21st July 1478 the Council of Eight came to the following resolution: "*item servatis etc. deliberaverunt et santiaverunt Sandro Botticelli pro ejus labore in pingendo proditores flor. quadraginta largos*" (see G. MILANESI, *Arch. star.* VI (1862) p. 5 note.) As has been told, Giuliano de' Medici was murdered on the 26th April 1478, and we see by this that only three months later Botticelli was paid for his painting of the "*proditores*". We can however hardly suppose that all the members of the conspiracy were depicted by him in fresco on the facade of the palace, since no fewer than eighty had been condemned to death. We have no means of knowing whether, besides Botticelli, any other painters, perhaps Leonardo, was commissioned, when the criminals had been hanged in person out of the windows of the Palazzo del Podestà to represent them there afterwards in effigy in memory of their disgrace. Nor do we know whether the assassin who had escaped may at first not have been provisionally represented as hanged in effigy. Now, when we try to connect the

historical facts with this drawing by Leonardo reproduced on Pl. LXII, No. I, and the full description of the conspirator's dress and its colour on the same sheet, there seems to be no reasonable doubt that Bernardo Bandini is here represented as he was actually hanged on December 29th, 1479, after his capture at Constantinople. The dress is certainly not that in which he committed the murder. A long furred coat might very well be worn at Constantinople or at Florence in December, but hardly in April. The doubt remains whether Leonardo described Bernardo's dress so fully because it struck him as remarkable, or whether we may not rather suppose that this sketch was actually made from nature with the intention of using it as a study for a wall painting to be executed. It cannot be denied that the drawing has all the appearance of having been made for this purpose. Be this as it may, the sketch under discussion proves, at any rate, that Leonardo was in Florence in December 1479, and the note that accompanies it is valuable as adding one more characteristic specimen to the very small number of his MSS. that can be proved to have been written between 1470 and 1480.]

Notes on the Last Supper (665-668).

665.

One who was drinking and has left the glass in its position and turned his head towards the speaker.

Another, twisting the fingers of his hands together turns with stern brows to his companion . Another with his hands spread open shows the palms, and shrugs his shoulders up his ears making a mouth of astonishment .

Another speaks into his neighbour's ear and he, as he listens to him, turns towards him to lend an ear , while he holds a knife in one hand, and in the other the loaf half cut through by the knife. Another who has turned, holding a knife in his hand, upsets with his hand a glass on the table .

[Footnote 665, 666: In the original MS. there is no sketch to accompany these passages, and if we compare them with those drawings made by Leonardo in preparation for the composition of the picture — Pl. XLV, XLVI — , (compare also Pl. LII, 1 and the drawings on p. 297) it is impossible to recognise in them a faithful interpretation of the whole of this text; but, if we compare these passages with the finished picture (see p. 334) we shall see that in many places they coincide. For instance, compare No. 665, 1. 6 — 8, with the fourth figure on the right hand of Christ. The various actions described in lines 9 — 10, 13 — 14 are to be seen in the group of Peter, John and Judas; in the finished picture however

it is not a glass but a salt cellar that Judas is upsetting.]

666.

Another lays his hand on the table and is looking. Another blows his mouthful. Another leans forward to see the speaker shading his eyes with his hand. Another draws back behind the one who leans forward, and sees the speaker between the wall and the man who is leaning [Footnote: 6. *chinato*. I have to express my regret for having misread this word, written *cinato* in the original, and having altered it to “*ciclo*” when I first published this text, in ‘The Academy’ for Nov. 8, 1879 immediately after I had discovered it, and subsequently in the small biography of Leonardo da Vinci (Great Artists) p. 29.].

[Footnote: In No. 666. Line I must refer to the furthest figure on the left; 3, 5 and 6 describe actions which are given to the group of disciples on the left hand of Christ.]

667.

CHRIST.

Count Giovanni, the one with the Cardinal of Mortaro.

[Footnote: As this note is in the same small Manuscript as the passage here immediately preceding it, I may be justified in assuming that Leonardo meant to use the features of the person here named as a suitable model for the figure of Christ. The celebrated drawing of the head of Christ, now hanging in the Brera Gallery at Milan, has obviously been so much restored that it is now impossible to say, whether it was ever genuine. We have only to compare it with the undoubtedly genuine drawings of heads of the disciples in PI. XLVII, XLVIII and L, to admit that not a single line of the Milan drawing in its present state can be by the same hand.]

668.

Philip, Simon, Matthew, Thomas, James the Greater, Peter, Philip, Andrew,

Bartholomew.

[Footnote: See PI. XLVI. The names of the disciples are given in the order in which they are written in the original, from right to left, above each head. The original drawing is here slightly reduced in scale; it measures 39 centimetres in length by 26 in breadth.]

669.

On the battle of Anghiari.

Florentine

Neri di Gino Capponi

Bernardetto de' Medici

Micheletto,

Niccolo da Pisa

Conte Francesco

Pietro Gian Paolo

Guelfo Orsino,

Messer Rinaldo degli

Albizzi

Begin with the address of Niccolo Piccinino to the soldiers and the banished Florentines among whom are Messer Rinaldo degli Albizzi and other Florentines. Then let it be shown how he first mounted on horseback in armour; and the whole army came after him — 40 squadrons of cavalry, and 2000 foot soldiers went with him. Very early in the morning the Patriarch went up a hill to reconnoitre the country, that is the hills, fields and the valley watered by a river; and from thence he beheld Niccolo Piccinino coming from Borgo San Sepolcro with his people, and with a great dust; and perceiving them he returned to the camp of his own people and addressed them. Having spoken he prayed to God with clasped hands, when there appeared a cloud in which Saint Peter appeared and spoke to the Patriarch. — 500 cavalry were sent forward by the Patriarch to hinder or check the rush of the enemy. In the foremost troop Francesco the son of Niccolo Piccinino was the first to attack the bridge which was held by the Patriarch and the Florentines. Beyond the bridge to his left he sent forward some infantry to engage ours, who drove them back, among whom was their captain Micheletto whose lot it was to be that day at the head of the army. Here, at this bridge there is a severe struggle; our men conquer and the enemy is repulsed. Here Guido and Astorre, his brother, the Lord of Faenza with a great number of men, re-formed and renewed the fight, and rushed upon the Florentines with

such force that they recovered the bridge and pushed forward as far as the tents. But Simonetto advanced with 600 horse, and fell upon the enemy and drove them back once more from the place, and recaptured the bridge; and behind him came more men with 2000 horse soldiers. And thus for a long time they fought with varying fortune. But then the Patriarch, in order to divert the enemy, sent forward Niccolo da Pisa and Napoleone Orsino, a beardless lad, followed by a great multitude of men, and then was done another great feat of arms. At the same time Niccolo Piccinino urged forward the remnant of his men, who once more made ours give way; and if it had not been that the Patriarch set himself at their head and, by his words and deeds controlled the captains, our soldiers would have taken to flight. The Patriarch had some artillery placed on the hill and with these he dispersed the enemy's infantry; and the disorder was so complete that Niccolo began to call back his son and all his men, and they took to flight towards Borgo. And then began a great slaughter of men; none escaped but the foremost of those who had fled or who hid themselves. The battle continued until sunset, when the Patriarch gave his mind to recalling his men and burying the dead, and afterwards a trophy was erected.

[Footnote: 669. This passage does not seem to me to be in Leonardo's hand, though it has hitherto been generally accepted as genuine. Not only is the writing unlike his, but the spelling also is quite different. I would suggest that this passage is a description of the events of the battle drawn up for the Painter by order of the Signoria, perhaps by some historian commissioned by them, to serve as a scheme or programme of the work. The whole tenor of the style seems to me to argue in favour of this theory; and besides, it would be in no way surprising that such a document should have been preserved among Leonardo's autographs.]

Allegorical representations referring to the duke of Milan (670-673).

670.

Ermine with blood Galeazzo, between calm weather and a representation of a tempest.

[Footnote: 670. Only the beginning of this text is legible; the writing is much effaced and the sense is consequently obscure. It seems to refer like the following passage to an allegorical picture.]

671.

Il Moro with spectacles, and Envy depicted with False Report and Justice black for il Moro.

Labour as having a branch of vine [*or a screw*] in her hand.

672.

Il Moro as representing Good Fortune, with hair, and robes, and his hands in front, and Messer Gualtieri taking him by the robes with a respectful air from below, having come in from the front .

Again, Poverty in a hideous form running behind a youth. Il Moro covers him with the skirt of his robe, and with his gilt sceptre he threatens the monster.

A plant with its roots in the air to represent one who is at his last; — a robe and Favour.

Of tricks [*or of magpies*] and of burlesque poems [*or of starlings*].

Those who trust themselves to live near him, and who will be a large crowd, these shall all die cruel deaths; and fathers and mothers together with their families will be devoured and killed by cruel creatures.

[Footnote: 1 — 10 have already been published by Amoretti in *Memorie Storiche* cap. XII. He adds this note with regard to Gualtieri: “A questo M. Gualtieri come ad uomo generoso e benefico scrive il Bellincioni un Sonetto (pag, 174) per chiedergli un piacere; e ‘l Tantio rendendo ragione a Lodovico il Moro, perche pubblicasse le Rime del Bellincioni; ciò hammi imposto, gli dice: *l’humano fidele, prudente e sollicito executore delli tuoi comandamenti Gualtero, che fa in tutte le cose ove tu possi far utile, ogni studio vi metti.*” A somewhat mysterious and evidently allegorical composition — a pen and ink drawing — at Windsor, see PL LVIII, contains a group of figures in which perhaps the idea is worked out which is spoken of in the text, lines 1-5.]

673.

He was blacker than a hornet, his eyes were as red as a burning fire and he rode on a tall horse six spans across and more than 20 long with six giants tied up to his saddle-bow and one in his hand which he gnawed with his teeth. And behind him came boars with tusks sticking out of their mouths, perhaps ten spans.

Allegorical representations (674 — 678).

674.

Above the helmet place a half globe, which is to signify our hemisphere, in the form of a world; on which let there be a peacock, richly decorated, and with his tail spread over the group; and every ornament belonging to the horse should be of peacock's feathers on a gold ground, to signify the beauty which comes of the grace bestowed on him who is a good servant.

On the shield a large mirror to signify that he who truly desires favour must be mirrored in his virtues.

On the opposite side will be represented Fortitude, in like manner in her place with her pillar in her hand, robed in white, to signify ... And all crowned; and Prudence with 3 eyes. The housing of the horse should be of plain cloth of gold closely sprinkled with peacock's eyes, and this holds good for all the housings of the horse, and the man's dress. And the man's crest and his neck-chain are of peacock's feathers on golden ground.

On the left side will be a wheel, the centre of which should be attached to the centre of the horse's hinder thigh piece, and in the centre Prudence is seen robed in red, Charity sitting in a fiery chariot and with a branch of laurel in her hand, to signify the hope which comes of good service.

Messer Antonio Grimani of Venice companion of Antonio Maria .

[Footnote: *Messer Antonio Gri*. His name thus abbreviated is, there can be no doubt, Grimani. Antonio Grimani was the famous Doge who in 1499 commanded the Venetian fleet in battle against the Turks. But after the abortive conclusion of the expedition — Ludovico being the ally of the Turks who took possession of Friuli — , Grimani was driven into exile; he went to live at Rome with his son Cardinal Domenico Grimani. On being recalled to Venice he filled the office of Doge from 1521 to 1523. *Antonio Maria* probably means Antonio Maria Grimani, the Patriarch of Aquileia.]

675.

Fame should be depicted as covered all over with tongues instead of feathers, and in the figure of a bird.

676.

Pleasure and Pain represent as twins, since there never is one without the other; and as if they were united back to back, since they are contrary to each other.

Clay, gold.

[Footnote: 7. *oro. fango*: gold, clay. These words stand below the allegorical figure.]

If you take Pleasure know that he has behind him one who will deal you Tribulation and Repentance.

This represents Pleasure together with Pain, and show them as twins because one is never apart from the other. They are back to back because they are opposed to each other; and they exist as contraries in the same body, because they have the same basis, inasmuch as the origin of pleasure is labour and pain, and the various forms of evil pleasure are the origin of pain. Therefore it is here represented with a reed in his right hand which is useless and without strength, and the wounds it inflicts are poisoned. In Tuscany they are put to support beds, to signify that it is here that vain dreams come, and here a great part of life is consumed. It is here that much precious time is wasted, that is, in the morning, when the mind is composed and rested, and the body is made fit to begin new labours; there again many vain pleasures are enjoyed; both by the mind in imagining impossible things, and by the body in taking those pleasures that are often the cause of the failing of life. And for these reasons the reed is held as their support.

[Footnote: 676. The pen and ink drawing on PI. LIX belongs to this passage.]

[Footnote: 8. *tribolatione*. In the drawing caltrops may be seen lying in the old man's right hand, others are falling and others again are shewn on the ground. Similar caltrops are drawn in MS. Tri. p. 98 and underneath them, as well as on page 96 the words *triboli di ferro* are written. From the accompanying text it appears that they were intended to be scattered on the ground at the bottom of ditches to hinder the advance of the enemy. Count Giulio Porro who published a short account of the Trivulzio MS. in the "*Archivio Storico Lombardo*", Anno VIII part IV (Dec. 31, 1881) has this note on the passages treating of "*triboli*": "*E qui aggiungerò che anni sono quando venne fabbricata la nuova cavallerizza presso il castello di Milano, ne furono trovati due che io ho veduto ed erano precisamente quali si trovano descritti e disegnati da Leonardo in questo codice*".

There can therefore be no doubt that this means of defence was in general use, whether it were originally Leonardo's invention or not. The play on the word "*tribolatione*", as it occurs in the drawing at Oxford, must then have been quite intelligible.]

[Footnote: 9 — 22. These lines, in the original, are written on the left side of the page and refer to the figure shown on PI. LXI. Next to it is placed the group of three figures given in PI. LX No. I. Lines 21 and 22, which are written under it, are the only explanation given.]

Evil-thinking is either Envy or Ingratitude.

677.

Envy must be represented with a contemptuous motion of the hand towards heaven, because if she could she would use her strength against God; make her with her face covered by a mask of fair seeming; show her as wounded in the eye by a palm branch and by an olive-branch, and wounded in the ear by laurel and myrtle, to signify that victory and truth are odious to her. Many thunderbolts should proceed from her to signify her evil speaking. Let her be lean and haggard because she is in perpetual torment. Make her heart gnawed by a swelling serpent, and make her with a quiver with tongues serving as arrows, because she often offends with it. Give her a leopard's skin, because this creature kills the lion out of envy and by deceit. Give her too a vase in her hand full of flowers and scorpions and toads and other venomous creatures; make her ride upon death, because Envy, never dying, never tires of ruling. Make her bridle, and load her with divers kinds of arms because all her weapons are deadly.

Toleration.

Intolerable.

No sooner is Virtue born than Envy comes into the world to attack it; and sooner will there be a body without a shadow than Virtue without Envy.

[Footnote: The larger of the two drawings on PI. LXI is explained by the first 21 lines of this passage. L. 22 and 23, which are written above the space between the two drawings, do not seem to have any reference to either. L. 24-27 are below the allegorical twin figure which they serve to explain.]

678.

When Pluto's Paradise is opened, then there may be devils placed in twelve pots like openings into hell. Here will be Death, the Furies, ashes, many naked children weeping; living fires made of various colours....

679.

John the Baptist

Saint Augustin

Saint Peter

Paul

Elisabeth

Saint Clara.

Bernardino

Our Lady Louis

Bonaventura

Anthony of Padua.

Saint Francis.

Francis,

Anthony, a lily and book;

Bernardino with the [monogram of] Jesus, Louis with 3 fleur de lys on his breast and the crown at his feet, Bonaventura with Seraphim, Saint Clara with the tabernacle, Elisabeth with a Queen's crown.

[Footnote: 679. The text of the first six lines is written within a square space of the same size as the copy here given. The names are written in the margin following the order in which they are here printed. In lines 7 — 12 the names of those saints are repeated of whom it seemed necessary to point out the emblems.]

List of drawings.

680.

A head, full face, of a young man with fine flowing hair,

Many flowers drawn from nature, A head, full face, with curly hair,
Certain figures of Saint Jerome, The measurements of a figure, Drawings of
furnaces.

A head of the Duke,

many designs for knots,

4 studies for the panel of Saint Angelo A small composition of Girolamo da
Fegline, A head of Christ done with the pen, 8 Saint Sebastians,

Several compositions of Angels, A chalcedony,

A head in profile with fine hair, Some pitchers seen in(?) perspective,

Some machines for ships,

Some machines for waterworks, A head, a portrait of Atalanta raising her face;

The head of Geronimo da Fegline, The head of Gian Francisco Borso, Several throats of old women, Several heads of old men,

Several nude figures, complete, Several arms, eyes, feet, and positions, A Madonna, finished,

Another, nearly in profile, Head of Our Lady ascending into Heaven, A head of an old man with long chin, A head of a gypsy girl,

A head with a hat on,

A representation of the Passion, a cast, A head of a girl with her hair gathered in a knot, A head, with the brown hair dressed.

[Footnote: 680. This has already been published by AMORETTI *Memorie storiche* cap. XVI. His reading varies somewhat from that here given, e. g. l. 5 and 6. *Certi Sangirolami in su d'una figura*; and instead of l. 13. *Un San Bastiano*.]

[Footnote: 680. 9. *Molti disegni di gruppi*. VASARI in his life of Leonardo (IV, 21, ed. MILANESI 1880) says: “*Oltrech  perse tempo fino a disegnare gruppi di corde fatti con ordine, e che da un capo seguissi tutto il resto fino all’ altro, tanto che s’empiessi un tondo; che se ne vede in istampa uno difficilissimo e molto bello, e nel mezzo vi sono queste parole: Leonardus Vinci Accademia*”. *Gruppi* must here be understood as a technical expression for those twisted ornaments which are well known through wood cuts. AMORETTI mentions six different ones in the Ambrosian Library. I am indebted to M. DELABORDE for kindly informing me that the original blocks of these are preserved in his department in the Biblioth que Nationale in Paris. On the cover of these volumes is a copy from one of them. The size of the original is 23 1/2 centimetres by 26 1/4. The centre portion of another is given on p. 361. G. Govi remarks on these ornaments (*Saggio* p. 22): “*Codesti gruppi eran probabilmente destinati a servir di modello a ferri da rilegatori per adornar le cartelle degli scolari (?)*. *Fregi somigliantissimi a questi troviamo infatti impressi in oro sui cartoni di vari volumi contemporanei, e li vediamo pur figurare nelle lettere iniziali di alcune edizioni del tempo.*”

D rer who copied them, omitting the inscription, added to the second impressions his own monogram. In his diary he designates them simply as “*Die sechs Knoten*” (see THAUSING, *Life of A. D rer* I, 362, 363). In Leonardo’s MSS. we find here and there little sketches or suggestions for similar ornaments. Compare too G. MONGERI, *L’Arte in Milano*, p. 315 where an ornament of the same character is given from the old decorations of the vaulted ceiling of the

Sacristy of S. Maria delle Grazie.]

[Footnote: 680, 17. The meaning in which the word *coppi*, literally pitchers, is here used I am unable to determine; but a change to *copie* seems to me too doubtful to be risked.]

681.

Stubborn rigour.

Doomed rigour.

[Footnote: See PI. LXII, No. 2, the two upper pen and ink drawings. The originals, in the Windsor collection are slightly washed with colour. The background is blue sky; the plough and the instrument with the compass are reddish brown, the sun is tinted yellow].

682.

Obstacles cannot crush me

Every obstacle yields to stern resolve He who is fixed to a star does not
change his mind.

[Footnote: This text is written to elucidate two sketches which were obviously the first sketches for the drawings reproduced on PL LXII, No. 2.]

683.

Ivy is [a type] of longevity.

[Footnote: In the original there is, near this text, a sketch of a coat wreathed above the waist with ivy.]

684.

Truth the sun. falsehood a mask. innocence, malignity.

Fire destroys falsehood, that is sophistry, and restores truth, driving out darkness.

Fire may be represented as the destroy of all sophistry, and as the image and demonstration of truth; because it is light and drives out darkness which conceals

all essences [or subtle things].

[Footnote: See PI. LXIII. L. 1-8 are in the middle of the page; 1. 9-14 to the right below; 1. 15-22 below in the middle column. The rest of the text is below the sketches on the left. There are some other passages on this page relating to geometry.]

TRUTH.

Fire destroys all sophistry, that is deceit; and maintains truth alone, that is gold.

Truth at last cannot be hidden. Dissimulation is of no avail. Dissimulation is to no purpose before so great a judge. Falsehood puts on a mask. Nothing is hidden under the sun.

Fire is to represent truth because it destroys all sophistry and lies; and the mask is for lying and falsehood which conceal truth.

685.

Movement will cease before we are weary
of being useful.

Movement will fail sooner than usefulness.

Death sooner than I am never weary of weariness. being useful,

In serving others I is a motto for carnival.

cannot do enough. Without fatigue.

No labour is

sufficient to tire me.

Hands into which ducats and precious stones fall like snow; they never become tired by serving, but this service is only for its utility and not for our I am never weary own benefit. of being useful.

Naturally nature has so disposed me.

686.

This shall be placed in the hand of Ingratitude. Wood nourishes the fire that consumes it.

687.

TO REPRESENT INGRATITUDE.

When the sun appears which dispels darkness in general, you put out the light which dispelled it for you in particular for your need and convenience.

688.

On this side Adam and Eve on the other; O misery of mankind, of how many things do you make yourself the slave for money!

[Footnote: See PI. LXIV. The figures of Adam and Eve in the clouds here alluded to would seem to symbolise their superiority to all earthly needs.]

689.

Thus are base unions sundered.

[Footnote: A much blurred sketch is on the page by this text. It seems to represent an unravelled plait or tissue.]

690.

Constancy does not begin, but is that which perseveres.

[Footnote: A drawing in red chalk, also rubbed, which stands in the original in the middle of this text, seems to me to be intended for a sword hilt, held in a fist.]

691.

Love, Fear, and Esteem, —

Write these on three stones. Of servants.

692.

Prudence Strength.

693.

Fame alone raises herself to Heaven, because virtuous things are in favour with God.

Disgrace should be represented upside down, because all her deeds are contrary to God and tend to hell.

694.

Short liberty.

695.

Nothing is so much to be feared as Evil Report.

This Evil Report is born of life.

696.

Not to disobey.

697.

A felled tree which is shooting again.

I am still hopeful.

A falcon,

Time.

[Footnote: I. *Albero tagliato*. This emblem was displayed during the Carnival at Florence in 1513. See VASARI VI, 251, ed. MILANESI 1881. But the coincidence is probably accidental.]

698.

Truth here makes Falsehood torment lying tongues.

699.

Such as harm is when it hurts me not, is good which avails me not.

[Footnote: See PI. LX, No. 2. Compare this sketch with that on PI. LXII, No. 2. Below the two lines of the text there are two more lines: *li gùchi (giunchi) che ritégò le paglucole (pagliucole) chelli (che li) anniegano.*]

700.

He who offends others, does not secure himself.

[Footnote: See PI. LX, No. 3.]

701.

Ingratitude.

[Footnote: See PI. LX, No. 4. Below the bottom sketches are the unintelligible words “*sta stilli.*” For “*Ingratitudo*” compare also Nos. 686 and 687.]

702.

One’s thoughts turn towards Hope.

[Footnote: 702. By the side of this passage is a sketch of a cage with a bird sitting in it.]

Ornaments and Decorations for feasts (703-705).

703.

A bird, for a comedy.

[Footnote: The biographies say so much, and the author’s notes say so little of the invention attributed to Leonardo of making artificial birds fly through the air, that the text here given is of exceptional interest from being accompanied by a sketch. It is a very slight drawing of a bird with outspread wings, which appears

to be sliding down a stretched string. Leonardo's flying machines and his studies of the flight of birds will be referred to later.]

704.

A DRESS FOR THE CARNIVAL.

To make a beautiful dress cut it in thin cloth and give it an odoriferous varnish, made of oil of turpentine and of varnish in grain, with a pierced stencil, which must be wetted, that it may not stick to the cloth; and this stencil may be made in a pattern of knots which afterwards may be filled up with black and the ground with white millet.[Footnote 7: The grains of black and white millet would stick to the varnish and look like embroidery.]

[Footnote: Ser Giuliano, da Vinci the painter's brother, had been commissioned, with some others, to order and to execute the garments of the Allegorical figures for the Carnival at Florence in 1515 — 16; VASARI however is incorrect in saying of the Florentine Carnival of 1513: "*equelli che feciono ed ordinarono gli abiti delle figure furono Ser Piero da Vinci, padre di Lonardo, e Bernardino di Giordano, bellissimi ingegni*" (See MILANESI'S ed. Voi. VI, pg. 251.)]

705.

Snow taken from the high peaks of mountains might be carried to hot places and let to fall at festivals in open places at summer time.

VOLUME II

XI. THE NOTES ON SCULPTURE.

Compared with the mass of manuscript treating of Painting, a very small number of passages bearing on the practice and methods of Sculpture are to be found scattered through the note books; these are here given at the beginning of this section (Nos. 706-709). There is less cause for surprise at finding that the equestrian statue of Francesco Sforza is only incidentally spoken of; for, although Leonardo must have worked at it for a long succession of years, it is not in the nature of the case that it could have given rise to much writing. We may therefore regard it as particularly fortunate that no fewer than thirteen notes in the master's handwriting can be brought together, which seem to throw light on the mysterious history of this famous work. Until now writers on Leonardo were acquainted only with the passages numbered 712, 719, 720, 722 and 723.

In arranging these notes on sculpture I have given the precedence to those which treat of the casting of the monument, not merely because they are the fullest, but more especially with a view to reconstructing the monument, an achievement which really almost lies within our reach by combining and comparing the whole of the materials now brought to light, alike in notes and in sketches.

A good deal of the first two passages, Nos. 710 and 711, which refer to this subject seems obscure and incomprehensible; still, they supplement each other and one contributes in no small degree to the comprehension of the other. A very interesting and instructive commentary on these passages may be found in the fourth chapter of Vasari's *Introduzione della Scultura* under the title "Come si fanno i modelli per fare di bronzo le figure grandi e picciole, e come le forme per buttarle; come si armino di ferri, e come si gettino di metallo," &c. Among the drawings of models of the moulds for casting we find only one which seems to represent the horse in the act of galloping — No. 713. All the other designs show the horse as pacing quietly and as these studies of the horse are accompanied by copious notes as to the method of casting, the question as to the position of the horse in the model finally selected, seems to be decided by preponderating evidence. "Il cavallo dello Sforza" — C. Boito remarks very appositely in the *Saggio* on page 26, "doveva sembrare fratello al cavallo del Colleoni. E si direbbe che questo fosse figlio del cavallo del Gattamelata, il quale pare figlio di uno dei quattro cavalli che stavano forse sull' Arco di Nerone

in Roma” (now at Venice). The publication of the *Saggio* also contains the reproduction of a drawing in red chalk, representing a horse walking to the left and supported by a scaffolding, given here on Pl. LXXVI, No. 1. It must remain uncertain whether this represents the model as it stood during the preparations for casting it, or whether — as seems to me highly improbable — this sketch shows the model as it was exhibited in 1493 on the Piazza del Castello in Milan under a triumphal arch, on the occasion of the marriage of the Emperor Maximilian to Bianca Maria Sforza. The only important point here is to prove that strong evidence seems to show that, of the numerous studies for the equestrian statue, only those which represent the horse pacing agree with the schemes of the final plans.

The second group of preparatory sketches, representing the horse as galloping, must therefore be considered separately, a distinction which, in recapitulating the history of the origin of the monument seems justified by the note given under No. 720.

Galeazza Maria Sforza was assassinated in 1476 before his scheme for erecting a monument to his father Francesco Sforza could be carried into effect. In the following year Ludovico il Moro the young aspirant to the throne was exiled to Pisa, and only returned to Milan in 1479 when he was Lord (Governatore) of the State of Milan, in 1480 after the minister Cecco Simonetta had been murdered. It may have been soon after this that Ludovico il Moro announced a competition for an equestrian statue, and it is tolerably certain that Antonio del Pollajuolo took part in it, from this passage in Vasari's *Life* of this artist: “E si trovo, dopo la morte sua, il disegno e modello che a Lodovico Sforza egli aveva fatto per la statua a cavallo di Francesco Sforza, duca di Milano; il quale disegno e nel nostro Libro, in due modi: in uno egli ha sotto Verona; nell'altro, egli tutto armato, e sopra un basamento pieno di battaglie, fa saltare il cavallo addosso a un armato; ma la cagione perche non mettesse questi disegni in opera, non ho gia potuto sapere.” One of Pollajuolo's drawings, as here described, has lately been discovered by Senatore Giovanni Morelli in the Munich Pinacothek. Here the profile of the horseman is a portrait of Francesco Duke of Milan, and under the horse, who is galloping to the left, we see a warrior thrown and lying on the ground; precisely the same idea as we find in some of Leonardo's designs for the monument, as on Pl. LXVI, LXVII, LXVIII, LXIX and LXXII No. 1; and, as it is impossible to explain this remarkable coincidence by supposing that either artist borrowed it from the other, we can only conclude that in the terms of the competition the subject proposed was the Duke on a horse in full gallop, with a fallen foe under its hoofs.

Leonardo may have been in the competition there and then, but the means for

executing the monument do not seem to have been at once forthcoming. It was not perhaps until some years later that Leonardo in a letter to the Duke (No. 719) reminded him of the project for the monument. Then, after he had obeyed a summons to Milan, the plan seems to have been so far modified, perhaps in consequence of a remonstrance on the part of the artist, that a pacing horse was substituted for one galloping, and it may have been at the same time that the colossal dimensions of the statue were first decided on. The designs given on Pl. LXX, LXXI, LXXII, 2 and 3, LXXIII and LXXIV and on pp. 4 and 24, as well as three sketches on Pl. LXIX may be studied with reference to the project in its new form, though it is hardly possible to believe that in either of these we see the design as it was actually carried out. It is probable that in Milan Leonardo worked less on drawings, than in making small models of wax and clay as preparatory to his larger model. Among the drawings enumerated above, one in black chalk, Pl. LXXIII — the upper sketch on the right hand side, reminds us strongly of the antique statue of Marcus Aurelius. If, as it would seem, Leonardo had not until then visited Rome, he might easily have known this statue from drawings by his former master and friend Verrocchio, for Verrocchio had been in Rome for a long time between 1470 and 1480. In 1473 Pope Sixtus IV had this antique equestrian statue restored and placed on a new pedestal in front of the church of San Giovanni in Luterano. Leonardo, although he was painting independently as early as in 1472 is still spoken of as working in Verrocchio's studio in 1477. Two years later the Venetian senate decided on erecting an equestrian statue to Colleoni; and as Verrocchio, to whom the work was entrusted, did not at once move from Florence to Venice — where he died in 1488 before the casting was completed — but on the contrary remained in Florence for some years, perhaps even till 1485, Leonardo probably had the opportunity of seeing all his designs for the equestrian statue at Venice and the red chalk drawing on Pl. LXXIV may be a reminiscence of it.

The pen and ink drawing on Pl. LXXII, No. 3, reminds us of Donatello's statue of Gattamelata at Padua. However it does not appear that Leonardo was ever at Padua before 1499, but we may conclude that he took a special interest in this early bronze statue and the reports he could procure of it, form an incidental remark which is to be found in C. A. 145a; 432a, and which will be given in Vol. II under Ricordi or Memoranda. Among the studies — in the widest sense of the word — made in preparation statue we may include the Anatomy of the Horse which Lomazzo and Vas mention; the most important parts of this work still exist in the Queen's Li Windsor. It was beyond a doubt compiled by Leonardo when at Milan; only interesting records to be found among these designs are reproduced in Nos. 716a but it must be pointed out that out of 40 sheets of

studies of the movements of the belonging to that treatise, a horse in full gallop occurs but once.

If we may trust the account given by Paulus Jovius — about 1527 — Leonardo's horse was represented as “vehementer incitatus et anhelatus”. Jovius had probably seen the model exhibited at Milan; but, need we, in fact, infer from this description that the horse was galloping? Compare Vasari's description of the Gattamelata monument at Padua: “Egli [Donatello] vi ando ben volentieri, e fece il cavallo di bronzo, che e in sulla piazza di Sant Antonio, nel quale si dimostra lo sbuffamento ed il fremito del cavallo, ed il grande animo e la fierezza vivacissimamente espressa dall'arte nella figura che lo cavalca”.

These descriptions, it seems to me, would only serve to mark the difference between the work of the middle ages and that of the renaissance.

We learn from a statement of Sabba da Castiglione that, when Milan was taken by the French in 1499, the model sustained some injury; and this informant, who, however is not invariably trustworthy, adds that Leonardo had devoted fully sixteen years to this work (la forma del cavallo, intorno a cui Leonardo avea sedici anni continui consumati). This often-quoted passage has given ground for an assumption, which has no other evidence to support it, that Leonardo had lived in Milan ever since 1483. But I believe it is nearer the truth to suppose that this author's statement alludes to the fact that about sixteen years must have past since the competition in which Leonardo had taken part.

I must in these remarks confine myself strictly to the task in hand and give no more of the history of the Sforza monument than is needed to explain the texts and drawings I have been able to reproduce. In the first place, with regard to the drawings, I may observe that they are all, with the following two exceptions, in the Queen's Library at Windsor Castle; the red chalk drawing on Pl. LXXVI No. 1 is in the MS. C. A. (see No. 712) and the fragmentary pen and ink drawing on page 4 is in the Ambrosian Library. The drawings from Windsor on Pl. LXVI have undergone a trifling reduction from the size of the originals.

There can no longer be the slightest doubt that the well-known engraving of several horsemen (Passavant, *Le Peintre-Graveur*, Vol. V, p. 181, No. 3) is only a copy after original drawings by Leonardo, executed by some unknown engraver; we have only to compare the engraving with the facsimiles of drawings on Pl. LXV, No. 2, Pl. LXVII, LXVIII and LXIX which, it is quite evident, have served as models for the engraver.

On Pl. LXV No. 1, in the larger sketch to the right hand, only the base is distinctly visible, the figure of the horseman is effaced. Leonardo evidently found it unsatisfactory and therefore rubbed it out.

The base of the monument — the pedestal for the equestrian statue — is

repeatedly sketched on a magnificent plan. In the sketch just mentioned it has the character of a shrine or aedicula to contain a sarcophagus. Captives in chains are here represented on the entablature with their backs turned to that portion of the monument which more

strictly constitutes the pedestal of the horse. The lower portion of the aedicula is surrounded by columns. In the pen and ink drawing Pl. LXVI — the lower drawing on the right hand side — the sarcophagus is shown between the columns, and above the entablature is a plinth on which the horse stands. But this arrangement perhaps seemed to Leonardo to lack solidity, and in the little sketch on the left hand, below, the sarcophagus is shown as lying under an arched canopy. In this the trophies and the captive warriors are detached from the angles. In the first of these two sketches the place for the trophies is merely indicated by a few strokes; in the third sketch on the left the base is altogether broader, buttresses and pinnacles having been added so as to form three niches. The black chalk drawing on Pl. LXVIII shows a base in which the angles are formed by niches with pilasters. In the little sketch to the extreme left on Pl. LXV, No. 1, the equestrian statue serves to crown a circular temple somewhat resembling Bramante's tempietto of San Pietro in Montorio at Rome, while the sketch above to the right displays an arrangement faintly reminding us of the tomb of the Scaligers in Verona. The base is thus constructed of two platforms or slabs, the upper one considerably smaller than the lower one which is supported on flying buttresses with pinnacles.

On looking over the numerous studies in which the horse is not galloping but merely walking forward, we find only one drawing for the pedestal, and this, to accord with the altered character of the statue, is quieter and simpler in style (Pl. LXXIV). It rises almost vertically from the ground and is exactly as long as the pacing horse. The whole base is here arranged either as an independent baldaquin or else as a projecting canopy over a recess in which the figure of the deceased Duke is seen lying on his sarcophagus; in the latter case it was probably intended as a tomb inside a church. Here, too, it was intended to fill the angles with trophies or captive warriors. Probably only No. 724 in the text refers to the work for the base of the monument.

If we compare the last mentioned sketch with the description of a plan for an equestrian monument to Gian Giacomo Trivulzio (No. 725) it seems by no means impossible that this drawing is a preparatory study for the very monument concerning which the manuscript gives us detailed information. We have no historical record regarding this sketch nor do the archives in the Trivulzio Palace give us any information. The simple monument to the great general in San Nazaro Maggiore in Milan consists merely of a sarcophagus placed in recess

high on the wall of an octagonal chapel. The figure of the warrior is lying on the sarcophagus, on which his name is inscribed; a piece of sculpture which is certainly not Leonardo's work. Gian Giacomo Trivulzio died at Chartres in 1518, only five months before Leonardo, and it seems to me highly improbable that this should have been the date of this sketch; under these circumstances it would have been done under the auspices of Francis I, but the Italian general was certainly not in favour with the French monarch at the time. Gian Giacomo Trivulzio was a sworn foe to Ludovico il Moro, whom he strove for years to overthrow. On the 6th September 1499 he marched victorious into Milan at the head of a French army. In a short time, however, he was forced to quit Milan again when Ludovico il Moro bore down upon the city with a force of Swiss troops. On the 15th of April following, after defeating Lodovico at Novara, Trivulzio once more entered Milan as a Conqueror, but his hopes of becoming *Governatore* of the place were soon wrecked by intrigue. This victory and triumph, historians tell us, were signalised by acts of vengeance against the dethroned Sforza, and it might have been particularly flattering to him that the casting and construction of the Sforza monument were suspended for the time.

It must have been at this moment — as it seems to me — that he commissioned the artist to prepare designs for his own monument, which he probably intended should find a place in the Cathedral or in some other church. He, the husband of Margherita di Nicolino Colleoni, would have thought that he had a claim to the same distinction and public homage as his less illustrious connection had received at the hands of the Venetian republic. It was at this very time that Trivulzio had a medal struck with a bust portrait of himself and the following remarkable inscription on the reverse: DEO FAVENTE — 1499 — DICTVS — 10 — IA — EXPVLIT — LVDOVICV — SF — (Sfortiam) DVC — (ducem) MLI (Mediolani) — NOIE (nomine) — REGIS — FRANCORVM — EODEM — ANN — (anno) RED'T (redit) — LVS (Ludovicus) — SVPERATVS ET CAPTVS — EST — AB — EO. In the Library of the Palazzo Trivulzio there is a MS. of Callimachus Siculus written at the end of the XVth or beginning of the XVIth century. At the beginning of this MS. there is an exquisite illuminated miniature of an equestrian statue with the name of the general on the base; it is however very doubtful whether this has any connection with Leonardo's design.

Nos. 731-740, which treat of casting bronze, have probably a very indirect bearing on the arrangements made for casting the equestrian statue of Francesco Sforza. Some portions evidently relate to the casting of cannon. Still, in our researches about Leonardo's work on the monument, we may refer to them as giving us some clue to the process of bronze casting at that period.

Some practical hints (706-709).

706.

OF A STATUE.

If you wish to make a figure in marble, first make one of clay, and when you have finished it, let it dry and place it in a case which should be large enough, after the figure is taken out of it, to receive also the marble, from which you intend to reveal the figure in imitation of the one in clay. After you have put the clay figure into this said case, have little rods which will exactly slip in to the holes in it, and thrust them so far in at each hole that each white rod may touch the figure in different parts of it. And colour the portion of the rod that remains outside black, and mark each rod and each hole with a countersign so that each may fit into its place. Then take the clay figure out of this case and put in your piece of marble, taking off so much of the marble that all your rods may be hidden in the holes as far as their marks; and to be the better able to do this, make the case so that it can be lifted up; but the bottom of it will always remain under the marble and in this way it can be lifted with tools with great ease.

707.

Some have erred in teaching sculptors to measure the limbs of their figures with threads as if they thought that these limbs were equally round in every part where these threads were wound about them.

708.

MEASUREMENT AND DIVISION OF A STATUE.

Divide the head into 12 degrees, and each degree divide into 12 points, and each point into 12 minutes, and the minutes into minims and the minims into semi minims.

Degree — point — minute — minim.

709.

Sculptured figures which appear in motion, will, in their standing position, actually look as if they were falling forward.

[Footnote: *figure di rilievo*. Leonardo applies this term exclusively to wholly detached figures, especially to those standing free. This note apparently refers to some particular case, though we have no knowledge of what that may have been. If we suppose it to refer to the first model of the equestrian statue of Francesco Sforza (see the introduction to the notes on Sculpture) this observation may be regarded as one of his arguments for abandoning the first scheme of the Sforza Monument, in which the horse was to be galloping (see page 2). It is also in favour of this theory that the note is written in a manuscript volume already completed in 1492. Leonardo's opinions as to the shortcomings of plastic works when compared with paintings are given under No. 655 and 656.]

Notes on the casting of the Sforza monument (710-715).

710.

Three braces which bind the mould.

[If you want to make simple casts quickly, make them in a box of river sand wetted with vinegar.]

[When you shall have made the mould upon the horse you must make the thickness of the metal in clay.]

Observe in alloying how many hours are wanted for each hundredweight. [In casting each one keep the furnace and its fire well stopped up.] [Let the inside of all the moulds be wetted with linseed oil or oil of turpentine, and then take a handful of powdered borax and Greek pitch with aqua vitae, and pitch the mould over outside so that being under ground the damp may not [damage it?]

[To manage the large mould make a model of the small mould, make a small room in proportion.]

[Make the vents in the mould while it is on the horse.]

Hold the hoofs in the tongs, and cast them with fish glue. Weigh the parts of the mould and the quantity of metal it will take to fill them, and give so much to the furnace that it may afford to each part its amount of metal; and this you may know by weighing the clay of each part of the mould to which the quantity in the furnace must correspond. And this is done in order that the furnace for the legs when filled may not have to furnish metal from the legs to help out the head,

which would be impossible. [Cast at the same casting as the horse the little door]

[Footnote: The importance of the notes included under this number is not diminished by the fact that they have been lightly crossed out with red chalk. Possibly they were the first scheme for some fuller observations which no longer exist; or perhaps they were crossed out when Leonardo found himself obliged to give up the idea of casting the equestrian statue. In the original the first two sketches are above l. 1, and the third below l. 9.]

711.

THE MOULD FOR THE HORSE.

Make the horse on legs of iron, strong and well set on a good foundation; then grease it and cover it with a coating, leaving each coat to dry thoroughly layer by layer; and this will thicken it by the breadth of three fingers. Now fix and bind it with iron as may be necessary. Moreover take off the mould and then make the thickness. Then fill the mould by degrees and make it good throughout; encircle and bind it with its irons and bake it inside where it has to touch the bronze.

OF MAKING THE MOULD IN PIECES.

Draw upon the horse, when finished, all the pieces of the mould with which you wish to cover the horse, and in laying on the clay cut it in every piece, so that when the mould is finished you can take it off, and then recompose it in its former position with its joins, by the countersigns.

The square blocks *a b* will be between the cover and the core, that is in the hollow where the melted bronze is to be; and these square blocks of bronze will support the intervals between the mould and the cover at an equal distance, and for this reason these squares are of great importance.

The clay should be mixed with sand.

Take wax, to return [what is not used] and to pay for what is used.

Dry it in layers.

Make the outside mould of plaster, to save time in drying and the expense in wood; and with this plaster enclose the irons [props] both outside and inside to a thickness of two fingers; make terra cotta. And this mould can be made in one

day; half a boat load of plaster will serve you.

Good.

Dam it up again with glue and clay, or white of egg, and bricks and rubbish.

[Footnote: See Pl. LXXV. The figure “40,” close to the sketch in the middle of the page between lines 16 and 17 has been added by a collector’s hand.

In the original, below line 21, a square piece of the page has been cut out about 9 centimetres by 7 and a blank piece has been gummed into the place.

Lines 22-24 are written on the margin. l. 27 and 28 are close to the second marginal sketch. l. 42 is a note written above the third marginal sketch and on the back of this sheet is the text given as No. 642. Compare also No. 802.]

712.

All the heads of the large nails.

[Footnote: See Pl. LXXVI, No. i. This drawing has already been published in the “*Saggio delle Opere di L. da Vinci.*” Milano 1872, Pl. XXIV, No. i. But, for various reasons I cannot regard the editor’s suggestions as satisfactory. He says: “*Veggonsi le armature di legname colle quali forse venne sostenuto il modello, quando per le nozze di Bianca Maria Sforza con Massimiliano imperatore, esso fu collocato sotto un arco trionfale davanti al Castello.*”

713.

These bindings go inside.

714.

Salt may be made from human excrements, burnt and calcined, made into lees and dried slowly at a fire, and all the excrements produce salt in a similar way and these salts when distilled, are very strong.

[Footnote: VASARI repeatedly states, in the fourth chapter of his *Introduzione della Scultura*, that in preparing to cast bronze statues horse-dung was frequently used by sculptors. If, notwithstanding this, it remains doubtful whether I am justified in having introduced here this text of but little interest, no such doubt can be attached to the sketch which accompanies it.]

715.

METHOD OF FOUNDING AGAIN.

This may be done when the furnace is made [Footnote: this note is written below the sketches.] strong and bruised.

Models for the horse of the Sforza monument (716-718).

716.

Messer Galeazzo's big genet

717.

Messer Galeazzo's Sicilian horse.

[Footnote: These notes are by the side of a drawing of a horse with figured measurements.]

718.

Measurement of the Sicilian horse the leg from behind, seen in front, lifted and extended.

[Footnote: There is no sketch belonging to this passage. Galeazze here probably means Galeazze di San Severino, the famous captain who married Bianca the daughter of Ludovico il Moro.]

Occasional references to the Sforza monument (719-724).

719.

Again, the bronze horse may be taken in hand, which is to be to the immortal glory and eternal honour of the happy memory of the prince your father, and of the illustrious house of Sforza.

[Footnote: The letter from which this passage is here extracted will be found complete in section XXI. (see the explanation of it, on page 2).]

720.

On the 23rd of April 1490 I began this book, and recommenced the horse.

721.

There is to be seen, in the mountains of Parma and Piacenza, a multitude of shells and corals full of holes, still sticking to the rocks, and when I was at work on the great horse for Milan, a large sackful of them, which were found thereabout, was brought to me into my workshop, by certain peasants.

722.

Believe me, Leonardo the Florentine, who has to do the equestrian bronze statue of the Duke Francesco that he does not need to care about it, because he has work for all his life time, and, being so great a work, I doubt whether he can ever finish it. [Footnote: This passage is quoted from a letter to a committee at Piacenza for whom Leonardo seems to have undertaken to execute some work. The letter is given entire in section XXL; in it Leonardo remonstrates as to some unreasonable demands.]

723.

Of the horse I will say nothing because I know the times. [Footnote: This passage occurs in a rough copy of a letter to Ludovico il Moro, without date (see below among the letters).]

724.

During ten years the works on the marbles have been going on I will not wait for my payment beyond the time, when my works are finished. [Footnote: This possibly refers to the works for the pedestal of the equestrian statue concerning which we have no farther information in the MSS. See p. 6.]

The project of the Trivulzio monument.

725.

**THE MONUMENT TO MESSER GIOVANNI JACOMO DA
TREVULZO.**

Cost of the making and materials for the horse .

[Footnote: In the original, lines 2-5, 12-14, 33-35, are written on the margin. This passage has been recently published by G. Govi in Vol. V, Ser. 3a, of *Transunti, Reale Accademia dei Lincei, sed. del 5 Giugno, 1881*, with the following introductory note: "*Desidero intanto che siano stampati questi pochi frammenti perche so che sono stati trascritti ultimamente, e verranno messi in luce tra poco fuori d'Italia. Li ripubblichi pure chi vuole, ma si sappia almeno che anche tra noi si conoscevano, e s'eran raccolti da anni per comporne, quando che fosse, una edizione ordinata degli scritti di Leonardo.*"

The learned editor has left out line 22 and has written 3 *pie* for 8 *piedi* in line 25. There are other deviations of less importance from the original.]

A courser, as large as life, with the rider requires for the cost of the metal, duc. 500.

And for cost of the iron work which is inside the model, and charcoal, and wood, and the pit to cast it in, and for binding the mould, and including the furnace where it is to be cast ... duc. 200.

To make the model in clay and then in wax..... duc. 432.

To the labourers for polishing it when it is cast. duc. 450.

in all. . duc. 1582.

Cost of the marble of the monument .

Cost of the marble according to the drawing. The piece of marble under the horse which is 4 braccia long, 2 braccia and 2 inches wide and 9 inches thick 58 hundredweight, at 4 Lire and 10 Soldi per hundredweight.. duc. 58.

And for 13 braccia and 6 inches of cornice, 7 in. wide and 4 in. thick, 24 hundredweight..... duc. 24.

And for the frieze and architrave, which is 4 br. and 6 in. long, 2 br. wide and 6 in. thick, 29 hundredweight., duc. 20.

And for the capitals made of metal, which are 8, 5 inches in. square and 2 in. thick, at the price of 15 ducats each, will come to..... duc. 122.

And for 8 columns of 2 br. 7 in., 4 1/2 in. thick, 20 hundredweight duc. 20.

And for 8 bases which are 5 1/2 in. square and 2 in. high 5 hund'.. duc. 5.

And for the slab of the tombstone 4 br. 10 in. long, 2 br. 4 1/2 in. wide 36 hundredweight..... duc. 36.

And for 8 pedestal feet each 8 br. long and 6 1/2 in. wide and 6 1/2 in. thick, 20 hundredweight come to... duc. 20.

And for the cornice below which is 4 br. and 10 in. long, and 2 br. and 5 in. wide, and 4 in. thick, 32 hund'.. duc. 32.

And for the stone of which the figure of the deceased is to be made which is 3 br. and 8 in. long, and 1 br. and 6 in. wide, and 9 in. thick, 30 hund'.. duc. 30.

And for the stone on which the figure lies which is 3 br. and 4 in. long and 1 br. and 2 in., wide and 4 1/2 in. thick duc. 16.

And for the squares of marble placed between the pedestals which are 8 and are 9 br. long and 9 in. wide, and 3 in. thick, 8 hundredweight . . . duc. 8. in all. . duc. 389.

Cost of the work in marble.

Round the base on which the horse stands there are 8 figures at 25 ducats each duc. 200.

And on the same base there are 8 festoons with some other ornaments, and of these there are 4 at the price of 15 ducats each, and 4 at the price of 8 ducats each duc. 92.

And for squaring the stones duc. 6.

Again, for the large cornice which goes below the base on which the horse stands, which is 13 br. and 6 in., at 2 due. per br. duc. 27.

And for 12 br. of frieze at 5 due. per br. duc. 60.

And for 12 br. of architrave at 1 1/2 duc. per br. duc. 18.

And for 3 rosettes which will be the soffit of the monument, at 20 ducats each duc. 60.

And for 8 fluted columns at 8 ducats each duc. 64.

And for 8 bases at 1 ducat each, duc. 8.

And for 8 pedestals, of which 4 are at 10 duc. each, which go above the angles; and 4 at 6 duc. each .. duc. 64.

And for squaring and carving the moulding of the pedestals at 2 duc. each, and there are 8 duc. 16.

And for 6 square blocks with figures and trophies, at 25 duc. each .. duc. 150.

And for carving the moulding of the stone under the figure of the deceased duc. 40.

For the statue of the deceased, to do it well duc. 100.

For 6 harpies with candelabra, at 25 ducats each duc. 150.

For squaring the stone on which the statue lies, and carving the moulding duc. 20.

in all .. duc. 1075.

The sum total of every thing added together amount to duc. 3046.

726.

MINT AT ROME.

It can also be made without a spring. But the screw above must always be joined to the part of the movable sheath: [Margin note: The mint of Rome.] [Footnote: See Pl. LXXVI. This passage is taken from a note book which can be proved to have been used in Rome.]

All coins which do not have the rim complete, are not to be accepted as good; and to secure the perfection of their rim it is requisite that, in the first place, all the coins should be a perfect circle; and to do this a coin must before all be made perfect in weight, and size, and thickness. Therefore have several plates of metal made of the same size and thickness, all drawn through the same gauge so as to come out in strips. And out of these strips you will stamp the coins, quite round, as sieves are made for sorting chestnuts ; and these coins can then be stamped in the way indicated above; &c.

The hollow of the die must be uniformly wider than the lower, but imperceptibly .

This cuts the coins perfectly round and of the exact thickness, and weight; and saves the man who cuts and weighs, and the man who makes the coins round. Hence it passes only through the hands of the gauger and of the stamper, and the coins are very superior. [Footnote: See Pl. LXXVI No. 2. The text of lines 31-35 stands parallel 1. 24-27.

Farther evidence of Leonardo's occupations and engagements at Rome under Pope Leo X. may be gathered from some rough copies of letters which will be found in this volume. Hitherto nothing has been known of his work in Rome beyond some doubtful, and perhaps mythical, statements in Vasari.]

727.

POWDER FOR MEDALS.

The incombustible growth of soot on wicks reduced to powder, burnt tin and all

the metals, alum, isinglass, smoke from a brass forge, each ingredient to be moistened, with aqua vitae or malmsey or strong malt vinegar, white wine or distilled extract of turpentine, or oil; but there should be little moisture, and cast in moulds. [Margin note: On the coining of medals (727. 728).] [Footnote: The meaning of *scagliuolo* in this passage is doubtful.]

728.

OF TAKING CASTS OF MEDALS.

A paste of emery mixed with aqua vitae, or iron filings with vinegar, or ashes of walnut leaves, or ashes of straw very finely powdered.

[Footnote: The meaning of *scagliuolo* in this passage is doubtful.]

The diameter is given in the lead enclosed; it is beaten with a hammer and several times extended; the lead is folded and kept wrapped up in parchment so that the powder may not be spilt; then melt the lead, and the powder will be on the top of the melted lead, which must then be rubbed between two plates of steel till it is thoroughly pulverised; then wash it with aqua fortis, and the blackness of the iron will be dissolved leaving the powder clean.

Emery in large grains may be broken by putting it on a cloth many times doubled, and hit it sideways with the hammer, when it will break up; then mix it little by little and it can be founded with ease; but if you hold it on the anvil you will never break it, when it is large.

Any one who grinds smalt should do it on plates of tempered steel with a cone shaped grinder; then put it in aqua fortis, which melts away the steel that may have been worked up and mixed with the smalt, and which makes it black; it then remains purified and clean; and if you grind it on porphyry the porphyry will work up and mix with the smalt and spoil it, and aqua fortis will never remove it because it cannot dissolve the porphyry.

If you want a fine blue colour dissolve the smalt made with tartar, and then remove the salt.

Vitrified brass makes a fine red.

729.

STUCCO.

Place stucco over the prominence of the..... which may be composed of Venus and Mercury, and lay it well over that prominence of the thickness of the side of a knife, made with the ruler and cover this with the bell of a still, and you will have again the moisture with which you applied the paste. The rest you may dry [Margin note: On stucco (729. 730).] [Footnote: In this passage a few words have been written in a sort of cipher — that is to say backwards; as in l. 3 *erenev* for *Venere*, l. 4 *oirucrem* for *Mercurio*, l. 12 *il orreve co ecarob* for *il everro* (?) *co borace*. The meaning of the word before “*di giesso*” in l. 1 is unknown; and the sense, in which *sagoma* is used here and in other passages is obscure. — *Venere* and *Mercurio* may mean ‘marble’ and ‘lime’, of which stucco is composed.

12. The meaning of *orreve* is unknown.]

well; afterwards fire it, and beat it or burnish it with a good burnisher, and make it thick towards the side.

STUCCO.

Powder ... with borax and water to a paste, and make stucco of it, and then heat it so that it may dry, and then varnish it, with fire, so that it shines well.

730.

STUCCO FOR MOULDING.

Take of butter 6 parts, of wax 2 parts, and as much fine flour as when put with these 2 things melted, will make them as firm as wax or modelling clay.

GLUE.

Take mastic, distilled turpentine and white lead.
On bronze casting generally (731-740).

731.

TO CAST.

Tartar burnt and powdered with plaster and cast cause the plaster to hold together when it is mixed up again; and then it will dissolve in water.

732.

TO CAST BRONZE IN PLASTER.

Take to every 2 cups of plaster 1 of ox-horns burnt, mix them together and make your cast with it.

733.

When you want to take a cast in wax, burn the scum with a candle, and the cast will come out without bubbles.

734.

2 ounces of plaster to a pound of metal; — walnut, which makes it like the curve.

[Footnote: The second part of this is quite obscure.]

735.

[Dried earth 16 pounds, 100 pounds of metal wet clay 20, — of wet 100,-half,-which increases 4 lbs. of water, — 1 of wax, 1 lb. of metal, a little less,-the scrapings of linen with earth, measure for measure.] [Footnote: The translation is given literally, but the meaning is quite obscure.]

736.

Such as the mould is, so will the cast be.

737.

HOW CASTS OUGHT TO BE POLISHED.

Make a bunch of iron wire as thick as thread, and scrub them with [this and] water; hold a bowl underneath that it may not make a mud below.

HOW TO REMOVE THE ROUGH EDGES FROM BRONZE.

Make an iron rod, after the manner of a large chisel, and with this rub over those seams on the bronze which remain on the casts of the guns, and which are caused by the joins in the mould; but make the tool heavy enough, and let the strokes be long and broad.

TO FACILITATE MELTING.

First alloy part of the metal in the crucible, then put it in the furnace, and this being in a molten state will assist in beginning to melt the copper.

TO PREVENT THE COPPER COOLING IN THE FURNACE.

When the copper cools in the furnace, be ready, as soon as you perceive it, to cut it with a long stick while it is still in a paste; or if it is quite cold cut it as lead is

cut with broad and large chisels.

IF YOU HAVE TO MAKE A LARGE CAST.

If you have to make a cast of a hundred thousand pounds do it with two furnaces and with 2000 pounds in each, or as much as 3000 pounds at most.

738.

HOW TO PROCEED TO BREAK A LARGE MASS OF BRONZE.

If you want to break up a large mass of bronze, first suspend it, and then make round it a wall on the four sides, like a trough of bricks, and make a great fire therein. When it is quite red hot give it a blow with a heavy weight raised above it, and with great force.

739.

TO COMBINE LEAD WITH OTHER METAL.

If you wish for economy in combining lead with the metal in order to lessen the amount of tin which is necessary in the metal, first alloy the lead with the tin and then add the molten copper.

How TO MELT [METAL] IN A FURNACE.

The furnace should be between four well founded pillars.

OF THE THICKNESS OF THE COATING.

The coating should not be more than two fingers thick, it should be laid on in four thicknesses over fine clay and then well fixed, and it should be fired only on the inside and then carefully covered with ashes and cow's dung.

OF THE THICKNESS OF THE GUN.

The gun being made to carry 600 lbs. of ball and more, by this rule you will take the measure of the diameter of the ball and divide it into 6 parts and one of these parts will be its thickness at the muzzle; but at the breech it must always be half. And if the ball is to be 700 lbs., $\frac{1}{7}$ th of the diameter of the ball must be its thickness in front; and if the ball is to be 800, the eighth of its diameter in front; and if 900, $\frac{1}{8}$ th and $\frac{1}{2}$, and if 1000, $\frac{1}{9}$ th.

OF THE LENGTH OF THE BODY OF THE GUN.

If you want it to throw a ball of stone, make the length of the gun to be 6, or as much as 7 diameters of the ball; and if the ball is to be of iron make it as much as 12 balls, and if the ball is to be of lead, make it as much as 18 balls. I mean when the gun is to have the mouth fitted to receive 600 lbs. of stone ball, and more.

OF THE THICKNESS OF SMALL GUNS.

The thickness at the muzzle of small guns should be from a half to one third of the diameter of the ball, and the length from 30 to 36 balls.

740.

OF LUTING THE FURNACE WITHIN.

The furnace must be luted before you put the metal in it, with earth from Valenza, and over that with ashes.

[Footnote 1. 2.: *Terra di Valenza*. — Valenza is north of Alessandria on the Po.]

OF RESTORING THE METAL WHEN IT IS BECOMING COOL.

When you see that the bronze is congealing take some willow-wood cut in small chips and make up the fire with it.

THE CAUSE OF ITS CURDLING.

I say that the cause of this congealing often proceeds from too much fire, or from ill-dried wood.

TO KNOW THE CONDITION OF THE FIRE.

You may know when the fire is good and fit for your purpose by a clear flame, and if you see the tips of the flames dull and ending in much smoke do not trust it, and particularly when the flux metal is almost fluid.

OF ALLOYING THE METAL.

Metal for guns must invariably be made with 6 or even 8 per cent, that is 6 of tin to one hundred of copper, for the less you put in, the stronger will the gun be.

WHEN THE TIN SHOULD BE ADDED TO THE COPPER.

The tin should be put in with the copper when the copper is reduced to a fluid.

HOW TO HASTEN THE MELTING.

You can hasten the melting when $\frac{2}{3}$ ds of the copper is fluid; you can then, with a stick of chestnut-wood, repeatedly stir what of copper remains entire amidst what is melted.

Introductory Observations on the Architectural Designs (XII), and Writings on Architecture (XIII).

Until now very little has been known regarding Leonardo's labours in the domain of Architecture. No building is known to have been planned and executed by him, though by some contemporary writers incidental allusion is made to his occupying himself with architecture, and his famous letter to

Lodovico il Moro, — which has long been a well-known document, — in which he offers his service as an architect to that prince, tends to confirm the belief that he was something more than an amateur of the art. This hypothesis has lately been confirmed by the publication of certain documents, preserved at Milan, showing that Leonardo was not only employed in preparing plans but that he took an active part, with much credit, as member of a commission on public buildings; his name remains linked with the history of the building of the Cathedral at Pavia and that of the Cathedral at Milan.

Leonardo's writings on Architecture are dispersed among a large number of MSS., and it would be scarcely possible to master their contents without the opportunity of arranging, sorting and comparing the whole mass of materials, so as to have some comprehensive idea of the whole. The sketches, when isolated and considered by themselves, might appear to be of but little value; it is not till we understand their general purport, from comparing them with each other, that we can form any just estimate of their true worth.

Leonardo seems to have had a project for writing a complete and separate treatise on Architecture, such as his predecessors and contemporaries had composed — Leon Battista Alberti, Filarete, Francesco di Giorgio and perhaps also Bramante. But, on the other hand, it cannot be denied that possibly no such scheme was connected with the isolated notes and researches, treating on special questions, which are given in this work; that he was merely working at problems in which, for some reason or other he took a special interest.

A great number of important buildings were constructed in Lombardy during the period between 1472 and 1499, and among them there are several by unknown architects, of so high an artistic merit, that it is certainly not improbable that either Bramante or Leonardo da Vinci may have been, directly or indirectly, concerned in their erection.

Having been engaged, for now nearly twenty years, in a thorough study of Bramante's life and labours, I have taken a particular interest in detecting the distinguishing marks of his style as compared with Leonardo's. In 1869 I made researches about the architectural drawings of the latter in the Codex Atlanticus at Milan, for the purpose of finding out, if possible the original plans and sketches of the churches of Santa Maria delle Grazie at Milan, and of the Cathedral at Pavia, which buildings have been supposed to be the work both of Bramante and of Leonardo. Since 1876 I have repeatedly examined Leonardo's architectural studies in the collection of his manuscripts in the Institut de France, and some of these I have already given to the public in my work on "Les Projets Primitifs pour la Basilique de St. Pierre de Rome", P1. 43. In 1879 I had the opportunity of examining the manuscript in the Palazzo Trivulzio at Milan,

and in 1880 Dr Richter showed me in London the manuscripts in the possession of Lord Ashburnham, and those in the British Museum. I have thus had opportunities of seeing most of Leonardo's architectural drawings in the original, but of the manuscripts themselves I have deciphered only the notes which accompany the sketches. It is to Dr Richter's exertions that we owe the collected texts on Architecture which are now published, and while he has undertaken to be responsible for the correct reading of the original texts, he has also made it his task to extract the whole of the materials from the various MSS. It has been my task to arrange and elucidate the texts under the heads which have been adopted in this work. MS. B. at Paris and the Codex Atlanticus at Milan are the chief sources of our knowledge of Leonardo as an architect, and I have recently subjected these to a thorough re-investigation expressly with a view to this work.

A complete reproduction of all Leonardo's architectural sketches has not, indeed, been possible, but as far as the necessarily restricted limits of the work have allowed, the utmost completeness has been aimed at, and no efforts have been spared to include every thing that can contribute to a knowledge of Leonardo's style. It would have been very interesting, if it had been possible, to give some general account at least of Leonardo's work and studies in engineering, fortification, canal-making and the like, and it is only on mature reflection that we have reluctantly abandoned this idea. Leonardo's occupations in these departments have by no means so close a relation to literary work, in the strict sense of the word as we are fairly justified in attributing to his numerous notes on Architecture.

Leonardo's architectural studies fall naturally under two heads:

I. Those drawings and sketches, often accompanied by short remarks and explanations, which may be regarded as designs for buildings or monuments intended to be built. With these there are occasionally explanatory texts.

II. Theoretical investigations and treatises. A special interest attaches to these because they discuss a variety of questions which are of practical importance to this day. Leonardo's theory as to the origin and progress of cracks in buildings is perhaps to be considered as unique in its way in the literature of Architecture.

HENRY DE GEYMULLER

XII. ARCHITECTURAL DESIGNS.

I. Plans for towns.

A. Sketches for laying out a new town with a double system of high-level and low-level roadways.

Pl. LXXVII, No. 1 (MS. B, 15b). A general view of a town, with the roads outside it sloping up to the high-level ways within.

Pl. LXXVII, No. 3 (MS. B, 16b. see No. 741; and MS. B. 15b, see No. 742) gives a partial view of the town, with its streets and houses, with explanatory references.

Pl. LXXVII, No. 2 (MS. B, 15b; see No. 743). View of a double staircaise with two opposite flights of steps.

Pl. LXXVIII, Nos. 2 and 3 (MS. B, 37a). Sketches illustrating the connection of the two levels of roads by means of steps. The lower galleries are lighted by openings in the upper roadway.

B. Notes on removing houses (MS. Br. M., 270b, see No. 744).

741.

The roads *m* are 6 braccia higher than the roads *p s*, and each road must be 20 braccia wide and have $\frac{1}{2}$ braccio slope from the sides towards the middle; and in the middle let there be at every braccio an opening, one braccio long and one finger wide, where the rain water may run off into hollows made on the same level as *p s*. And on each side at the extremity of the width of the said road let there be an arcade, 6 braccia broad, on columns; and understand that he who would go through the whole place by the high level streets can use them for this purpose, and he who would go by the low level can do the same. By the high streets no vehicles and similar objects should circulate, but they are exclusively for the use of gentlemen. The carts and burdens for the use and convenience of the inhabitants have to go by the low ones. One house must turn its back to the other, leaving the lower streets between them. Provisions, such as wood, wine and such things are carried in by the doors *n*, and privies, stables and other fetid matter must be emptied away underground. From one arch to the next

742.

must be 300 braccia, each street receiving its light through the openings of the upper streets, and at each arch must be a winding stair on a circular plan because the corners of square ones are always fouled; they must be wide, and at the first vault there must be a door entering into public privies and the said stairs lead from the upper to the lower streets and the high level streets begin outside the city gates and slope up till at these gates they have attained the height of 6 braccia. Let such a city be built near the sea or a large river in order that the dirt of the city may be carried off by the water.

743.

The construction of the stairs: The stairs $c d$ go down to $f g$, and in the same way $f g$ goes down to $h k$.

744.

ON MOVING HOUSES.

Let the houses be moved and arranged in order; and this will be done with facility because such houses are at first made in pieces on the open places, and can then be fitted together with their timbers in the site where they are to be permanent.

Let the men of the country [or the village] partly inhabit the new houses when the court is absent .

[Footnote: On the same page we find notes referring to Romolontino and Villafranca with a sketch-map of the course of the “Sodro” and the “(Lo)cra” (both are given in the text farther on). There can hardly be a doubt that the last sentence of the passage given above, refers to the court of Francis I. King of France. — L.9-13 are written inside the larger sketch, which, in the original, is on the right hand side of the page by the side of lines 1-8. The three smaller sketches are below. J. P. R.]

II. Plans for canals and streets in a town.

Pl. LXXIX, 1. and 2, (MS. B, 37b, see No. 745, and MS. B. 36a, see No. 746).
A Plan for streets and canals inside a town, by which the cellars of the houses are made accessible in boats.

The third text given under No. 747 refers to works executed by Leonardo in France.

745.

The front *a m* will give light to the rooms; *a e* will be 6 braccia — *a b* 8 braccia — *b e* 30 braccia, in order that the rooms under the porticoes may be lighted; *c d f* is the place where the boats come to the houses to be unloaded. In order to render this arrangement practicable, and in order that the inundation of the rivers may not penetrate into the cellars, it is necessary to chose an appropriate situation, such as a spot near a river which can be diverted into canals in which the level of the water will not vary either by inundations or drought. The construction is shown below; and make choice of a fine river, which the rains do not render muddy, such as the Ticino, the Adda and many others. [Footnote 12: *Tesino, Adda e molti altri, i.e.* rivers coming from the mountains and flowing through lakes.] The construction to oblige the waters to keep constantly at the same level will be a sort of dock, as shown below, situated at the entrance of the town; or better still, some way within, in order that the enemy may not destroy it .

[Footnote: L. 1-4 are on the left hand side and within the sketch given on Pl. LXXIX, No. I. Then follows after line 14, the drawing of a sluiceway — *conca* — of which the use is explained in the text below it. On the page 38a, which comes next in the original MS. is the sketch of an oval plan of a town over which is written “*modo di canali per la citta*” and through the longer axis of it “*canale magior*” is written with “*Tesino*” on the prolongation of the canal. J. P. R.]

746.

Let the width of the streets be equal to the average height of the houses.

747.

The main underground channel does not receive turbid water, but that water

runs in the ditches outside the town with four mills at the entrance and four at the outlet; and this may be done by damming the water above Romorantin.

There should be fountains made in each piazza.

[Footnote: In the original this text comes immediately after the passage given as No. 744. The remainder of the writing on the same page refers to the construction of canals and is given later, in the "Topographical Notes".

Lines 1-11 are written to the right of the plan lines 11-13 underneath it. J. P. R.]

[Footnote 10: *Romolontino* is Romorantin, South of Orleans in France.]

III. Castles and Villas.

A. Castles.

Pl. LXXX, No. 1 (P. V. fol. 39b; No. d'ordre 2282). The fortified place here represented is said by Vallardi to be the "castello" at Milan, but without any satisfactory reason. The high tower behind the "rivellino" ravelin — seems to be intended as a watch-tower.

Pl. LXXX, No. 2 (MS. B, 23b). A similarly constructed tower probably intended for the same use.

Pl. LXXX, No. 3 (MS. B). Sketches for corner towers with steps for a citadel.

Pl. LXXX, No. 4 (W. XVI). A cupola crowning a corner tower; an interesting example of decorative fortification. In this reproduction of the original pen and ink drawing it appears reversed.

B. Projects for Palaces.

Pl. LXXXI, No. 2 (MS. C. A, 75b; 221a, see No. 748). Project for a royal residence at Amboise in France.

Pl. LXXXII, No. 1 (C. A 308a; 939a). A plan for a somewhat extensive residence, and various details; but there is no text to elucidate it; in courts are written the three names:

Sam cosi giova (*St. Mark*) (*Cosmo*) (*John*), arch mo nino

C. Plans for small castles or Villas.

The three following sketches greatly resemble each other. Pl.

LXXXII, No. 2 (MS. K3 36b; see No. 749).

Pl. LXXXII, No. 3 (MS. B 60a; See No. 750).

Pl. LXXXIII (W. XVII). The text on this sheet refers to Cyprus (see Topographical Notes No. 1103), but seems to have no direct connection with the sketches inserted between.

Pl. LXXXVIII, Nos. 6 and 7 (MS. B, 12a; see No. 751). A section of a circular pavilion with the plan of a similar building by the side of it. These two drawings have a special historical interest because the text written below mentions the

Duke and Duchess of Milan.

The sketch of a villa on a terrace at the end of a garden occurs in C. A. 150; and in C. A. 77b; 225b is another sketch of a villa somewhat resembling the Belvedere of Pope Innocent VIII, at Rome.

In C. A. 62b; 193b there is a Loggia.

Pl. LXXXII, No. 4 (C. A. 387a; 1198a) is a tower-shaped Loggia *above a fountain. The machinery is very ingeniously screened from view.*

748.

The Palace of the prince must have a piazza in front of it.

Houses intended for dancing or any kind of jumping or any other movements with a multitude of people, must be on the ground-floor; for I have already witnessed the destruction of some, causing death to many persons, and above all let every wall, be it ever so thin, rest on the ground or on arches with a good foundation.

Let the mezzanines of the dwellings be divided by walls made of very thin bricks, and without wood on account of fire.

Let all the privies have ventilation [by shafts] in the thickness of the walls, so as to exhale by the roofs.

The mezzanines should be vaulted, and the vaults will be stronger in proportion as they are of small size.

The ties of oak must be enclosed in the walls in order to be protected from fire.

[Footnote: The remarks accompanying the plan reproduced on Pl. LXXXI, No. 2 are as follows: Above, to the left: "*in a angholo stia la guardia de la sstalla*" (in the angle *a* may be the keeper of the stable). Below are the words "*strada dabosa*" (road to Amboise), parallel with this "*fossa br 40*" (*the moat 40 braccia*) *fixing the width of the moat. In the large court surrounded by a portico "in terre No. — Largha br.80 e lugha br 120."* To the right of the castle is a large basin for aquatic sports with the words "*Giostre colle nave cioe li giostra li stieno sopra le na*" (Jousting in boats that is the men are to be in boats). J. P. R.]

The privies must be numerous and going one into the other in order that the stench may not penetrate into the dwellings., and all their doors must shut off themselves with counterpoises.

The main division of the facade of this palace is into two portions; that is to say the width of the courtyard must be half the whole facade; the 2nd ...

749.

30 braccia wide on each side; the lower entrance leads into a hall 10 braccia wide and 30 braccia long with 4 recesses each with a chimney.

[Footnote: On each side of the castle, Pl. LXXXII. No. 2 there are drawings of details, to the left “*Camino*” a chimney, to the right the central lantern, sketched in red “*8 lati*” i.e. an octagon.]

750.

The firststorey [or terrace] must be entirely solid.

751.

The pavilion in the garden of the Duchess of Milan.

The plan of the pavilion which is in the middle of the labyrinth of the Duke of Milan.

[Footnote: This passage was first published by AMORETTI in *Memorie Storiche* Cap. X: Una sua opera da riportarsi a quest’ anno fu il bagno fatto per la duchessa Beatrice nel parco o giardino del Castello. Lionardo non solo ne disegno il piccolo edificio a foggia di padiglione, nel cod. segnato Q. 3, dandone anche separatamente la pianta; ma sotto vi scrisse: Padiglione del giardino della duchessa; e sotto la pianta: Fondamento del padiglione ch’è nel mezzo del labirinto del duca di Milano; nessuna data e presso il padiglione, disegnato nella pagina 12, ma poco sopra fra molti circoli intrecciati vedesi = 10 Luglio 1492 = e nella pagina 2 presso ad alcuni disegni di legumi qualcheduno ha letto Settembre 1482 in vece di 1492, come dovea scrivervi, e probabilmente scrisse Lionardo.

The original text however hardly bears the interpretation put upon it by AMORETTI. He is mistaken as to the mark on the MS. as well as in his statements as to the date, for the MS. in question has no date; the date he gives occurs, on the contrary, in another note-book. Finally, it appears to me quite an open question whether Leonardo was the architect who carried out the construction of the dome-like Pavilion here shown in section, or of the ground plan of the Pavilion drawn by the side of it. Must we, in fact, suppose that “*il duca di Milano*” here mentioned was, as has been generally assumed, Ludovico

il Moro? He did not hold this title from the Emperor before 1494; till that date he was only called *Governatore* and Leonardo in speaking of him, mentions him generally as “*il Moro*” even after 1494. On January 18, 1491, he married Beatrice d’Este the daughter of Ercole I, Duke of Ferrara. She died on the 2nd January 1497, and for the reasons I have given it seems improbable that it should be this princess who is here spoken of as the “*Duchessa di Milano*”. From the style of the handwriting it appears to me to be beyond all doubt that the MS. B, from which this passage is taken, is older than the dated MSS. of 1492 and 1493. In that case the Duke of Milan here mentioned would be Gian Galeazzo (1469-1494) and the Duchess would be his wife Isabella of Aragon, to whom he was married on the second February 1489. J. P. R.]

752.

The earth that is dug out from the cellars must be raised on one side so high as to make a terrace garden as high as the level of the hall; but between the earth of the terrace and the wall of the house, leave an interval in order that the damp may not spoil the principal walls.

IV. Ecclesiastical Architecture.

A. General Observations.

753.

A building should always be detached on all sides so that its form may be seen.

[Footnote: The original text is reproduced on Pl. XCII, No. 1 to the left hand at the bottom.]

754.

Here there cannot and ought not to be any *campanile*; on the contrary it must stand apart like that of the Cathedral and of San Giovanni at Florence, and of the Cathedral at Pisa, where the *campanile* is quite detached as well as the dome. Thus each can display its own perfection. If however you wish to join it to the church, make the lantern serve for the *campanile* as in the church at Chiaravalle.

[Footnote: This text is written by the side of the plan given on Pl.

XCI. No. 2.]

[Footnote 12: The Abbey of Chiaravalle, a few miles from Milan, has a central tower on the intersection of the cross in the style of that of the Certosa of Pavia, but the style is mediaeval (A. D. 1330). Leonardo seems here to mean, that in a building, in which the circular form is strongly conspicuous, the campanile must either be separated, or rise from the centre of the building and therefore take the form of a lantern.]

755.

It never looks well to see the roofs of a church; they should rather be flat and the water should run off by gutters made in the frieze.

[Footnote: This text is to the left of the domed church reproduced on Pl. LXXXVII, No. 2.]

B. The theory of Dome Architecture.

This subject has been more extensively treated by Leonardo in drawings than in writing. Still we may fairly assume that it was his purpose, ultimately to embody the results of his investigation in a “Trattato delle Cupole.” The amount of materials is remarkably extensive. MS. B is particularly rich in plans and elevations of churches with one or more domes — from the simplest form to the most complicated that can be imagined. Considering the evident connexion between a great number of these sketches, as well as the impossibility of seeing in them designs or preparatory sketches for any building intended to be erected, the conclusion is obvious that they were not designed for any particular monument, but were theoretical and ideal researches, made in order to obtain a clear understanding of the laws which must govern the construction of a great central dome, with smaller ones grouped round it; and with or without the addition of spires, so that each of these parts by itself and in its juxtaposition to the other parts should produce the grandest possible effect.

In these sketches Leonardo seems to have exhausted every imaginable combination. [Footnote 1: In MS. B, 32b (see Pl. C III, No. 2) we find eight geometrical patterns, each drawn in a square; and in MS. C.A., fol. 87 to 98 form a whole series of patterns done with the same intention.] The results of some of these problems are perhaps not quite satisfactory; still they cannot be considered to give evidence of a want of taste or of any other defect in Leonardo's architectural capacity. They were no doubt intended exclusively for his own instruction, and, before all, as it seems, to illustrate the features or consequences resulting from a given principle.

I have already, in another place, [Footnote 1: Les Projets Primitifs pour la Basilique de St. Pierre de Rome, par Bramante, Raphael etc., Vol. I, p. 2.] pointed out the law of construction for buildings crowned by a large dome: namely, that such a dome, to produce the greatest effect possible, should rise either from the centre of a Greek cross, or from the centre of a structure of which the plan has some symmetrical affinity to a circle, this circle being at the same time the centre of the whole plan of the building.

Leonardo's sketches show that he was fully aware, as was to be expected, of this truth. Few of them exhibit the form of a Latin cross, and when this is met with, it generally gives evidence of the determination to assign as prominent a part as possible to the dome in the general effect of the building.

While it is evident, on the one hand, that the greater number of these domes had no particular purpose, not being designed for execution, on the other hand several reasons may be found for Leonardo's perseverance in his studies of the subject.

Besides the theoretical interest of the question for Leonardo and his *Trattato and besides the taste for domes prevailing at that time, it seems likely that the intended erection of some building of the first importance like the Duomos of Pavia and Como, the church of Sta. Maria delle Grazie at Milan, and the construction of a Dome or central Tower (Tiburio) on the cathedral of Milan,* may have stimulated Leonardo to undertake a general and thorough investigation of the subject; whilst Leonardo's intercourse with Bramante for ten years or more, can hardly have remained without influence in this matter. In fact now that some of this great Architect's studies for S. Peter's at Rome have at last become known, he must be considered henceforth as the greatest master of Dome-Architecture that ever existed. His influence, direct or indirect even on a genius like Leonardo seems the more likely, since Leonardo's sketches reveal a style most similar to that of Bramante, whose name indeed, occurs twice in Leonardo's manuscript notes. It must not be forgotten that Leonardo was a Florentine; the characteristic form of the two principal domes of Florence, Sta. Maria del Fiore and the Battisterio, constantly appear as leading features in his sketches.

The church of San Lorenzo at Milan, was at that time still intact. The dome is to this day one of the most wonderful cupolas ever constructed, and with its two smaller domes might well attract the attention and study of a never resting genius such as Leonardo. A whole class of these sketches betray in fact the direct influence of the church of S. Lorenzo, and this also seems to have suggested the plan of Bramante's dome of St. Peter's at Rome.

In the following pages the various sketches for the construction of domes have

been classified and discussed from a general point of view. On two sheets: Pl. LXXXIV (C.A. 354b; 118a) and Pl. LXXXV, Nos. 1-11 (Ash. II, 6b) we see various dissimilar types, grouped together; thus these two sheets may be regarded as a sort of nomenclature of the different types, on which we shall now have to treat.

1. Churches formed on the plan of a Greek cross.

Group I.

Domes rising from a circular base.

The simplest type of central building is a circular edifice.

Pl. LXXXIV, No. 9. Plan of a circular building surrounded by a colonnade.

Pl. LXXXIV, No. 8. Elevation of the former, with a conical roof.

Pl. XC. No. 5. A dodecagon, as most nearly approaching the circle.

Pl. LXXXVI, No. 1, 2, 3. Four round chapels are added at the extremities of the two principal axes; — compare this plan with fig. 1 on p. 44 and fig. 3 on p. 47 (W. P. 5b) where the outer wall is octagonal.

Group II.

Domes rising from a square base.

The plan is a square surrounded by a colonnade, and the dome seems to be octagonal.

Pl. LXXXIV. The square plan below the circular building No. 8, and its elevation to the left, above the plan: here the ground-plan is square, the upper storey octagonal. A further development of this type is shown in two sketches C. A. 3a (not reproduced here), and in

Pl. LXXXVI, No. 5 (which possibly belongs to No. 7 on Pl. LXXXIV).

Pl. LXXXV, No. 4, and p. 45, Fig. 3, a Greek cross, repeated p. 45,

Fig. 3, is another development of the square central plan.

The remainder of these studies show two different systems; in the first the dome rises from a square plan, — in the second from an octagonal base.

Group III.

Domes rising from a square base and four pillars. [Footnote 1: The ancient chapel San Satiro, via del Falcone, Milan, is a specimen of this type.]

a) First type. A Dome resting on four pillars in the centre of a square edifice, with an apse in the middle, of each of the four sides. We have eleven variations of this type.

aa) Pl. LXXXVIII, No. 3.

bb) Pl. LXXX, No. 5.

cc) Pl. LXXXV, Nos. 2, 3, 5.

dd) Pl. LXXXIV, No. 1 and 4 beneath.

ee) Pl. LXXXV, Nos. 1, 7, 10, 11.

b) Second type. This consists in adding aisles to the whole plan of the first type; columns are placed between the apses and the aisles; the plan thus obtained is very nearly identical with that of S. Lorenzo at Milan.

Fig. 1 on p. 56. (MS. B, 75a) shows the result of this treatment adapted to a peculiar purpose about which we shall have to say a few words later on.

Pl. XCV, No. 1, shows the same plan but with the addition of a short nave. This plan seems to have been suggested by the general arrangement of S. Sepolcro at Milan.

MS. B. 57b (see the sketch reproduced on p.51). By adding towers in the four outer angles to the last named plan, we obtain a plan which bears the general features of Bramante's plans for S. Peter's at Rome. [Footnote 2: See *Les projets primitifs* etc., Pl. 9-12.] (See p. 51 Fig. 1.)

Group IV.

Domes rising from an octagonal base.

This system, developed according to two different schemes, has given rise to two classes with many varieties.

In a) On each side of the octagon chapels of equal form are added.

In b) The chapels are dissimilar; those which terminate the principal axes being different in form from those which are added on the diagonal sides of the octagon.

a. First Class.

The Chapel "degli Angeli," at Florence, built only to a height of about 20 feet by Brunellesco, may be considered as the prototype of this group; and, indeed it probably suggested it. The fact that we see in MS. B. 11b (Pl. XCIV, No. 3) by the side of Brunellesco's plan for the Basilica of Sto. Spirito at Florence, a plan almost identical with that of the Capella degli Angeli, confirms this supposition. Only two small differences, or we may say improvements, have been introduced by Leonardo. Firstly the back of the chapels contains a third niche, and each angle of the Octagon a folded pilaster like those in Bramante's Sagrestia di S. M. presso San Satiro at Milan, instead of an interval between the two pilasters as seen in the Battistero at Florence and in the Sacristy of Sto. Spirito in the same town and also in the above named chapel by Brunellesco.

The first set of sketches which come under consideration have at first sight the appearance of mere geometrical studies. They seem to have been suggested by the plan given on page 44 Fig. 2 (MS. B, 55a) in the centre of which is written "Santa Maria in perticha da Pavia", at the place marked A on the reproduction.

a) (MS. B, 34b, page 44 Fig. 3). In the middle of each side a column is added, and in the axes of the intercolumnar spaces a second row of columns forms an aisle round the octagon. These are placed at the intersection of a system of

semicircles, of which the sixteen columns on the sides of the octagon are the centres.

b) The preceding diagram is completed and becomes more monumental in style in the sketch next to it (MS. B, 35a, see p. 45 Fig. 1). An outer aisle is added by circles, having for radius the distance between the columns in the middle sides of the octagon.

c) (MS. B. 96b, see p. 45 Fig. 2). Octagon with an aisle round it; the angles of both are formed by columns. The outer sides are formed by 8 niches forming chapels. The exterior is likewise octagonal, with the angles corresponding to the centre of each of the interior chapels.

Pl. XCII, No. 2 (MS. B. 96b). Detail and modification of the preceding plan — half columns against piers — an arrangement by which the chapels of the aisle have the same width of opening as the inner arches between the half columns. Underneath this sketch the following note occurs: *questo vole - avere 12 facce - co 12 tabernaculi - come - a - b. (This will have twelve sides with twelve tabernacles as a b.)* In the remaining sketches of this class the octagon is not formed by columns at the angles.

The simplest type shows a niche in the middle of each side and is repeated on several sheets, viz: MS. B 3; MS. C.A. 354b (see Pl. LXXXIV, No. 11) and MS. Ash II 6b; (see Pl. LXXXV, No. 9 and the elevations No. 8; Pl. XCII, No. 3; MS. B. 4b [not reproduced here] and Pl. LXXXIV, No. 2).

Pl. XCII, 3 (MS. B, 56b) corresponds to a plan like the one in MS. B 35a, in which the niches would be visible outside or, as in the following sketch, with the addition of a niche in the middle of each chapel.

Pl. XC, No. 6. The niches themselves are surrounded by smaller niches (see also No. 1 on the same plate).

Octagon expanded on each side.

A. by a square chapel:

MS. B. 34b (not reproduced here).

B. by a square with 3 niches:

MS. B. 11b (see Pl. XCIV, No. 3).

C. by octagonal chapels:

a) MS. B, 21a; Pl. LXXXVIII, No. 4.

b) No. 2 on the same plate. Underneath there is the remark: *"quest'e come le 8 cappele ano a essere facte"* (this is how the eight chapels are to be executed).

c) Pl. LXXXVIII, No. 5. Elevation to the plans on the same sheet, it is accompanied by the note: *"ciasscuno de' 9 tiburini no'uole - passare l'alteza - di - 2 - quadri"* (neither of the 9 domes must exceed the height of two squares).

d) Pl. LXXXVIII, No. 1. Inside of the same octagon. MS. B, 30a, and 34b;

these are three repetitions of parts of the same plan with very slight variations.

D. by a circular chapel:

MS. B, 18a (see Fig. 1 on page 47) gives the plan of this arrangement in which the exterior is square on the ground floor with only four of the chapels projecting, as is explained in the next sketch.

Pl. LXXXIX, MS. B, 17b. Elevation to the preceding plan sketched on the opposite side of the sheet, and also marked A. It is accompanied by the following remark, indicating the theoretical character of these studies: *questo - edifitio - anchora - starebbe - bene affarlo dalla linja - a - b - c - d - insu. ("This edifice would also produce a good effect if only the part above the lines a b, c d, were executed")*.

Pl. LXXXIV, No. 11. The exterior has the form of an octagon, but the chapels project partly beyond it. On the left side of the sketch they appear larger than on the right side.

Pl. XC, No. 1, (MS. B, 25b); Repetition of Pl. LXXXIV, No. 11.

Pl. XC, No. 2. Elevation to the plan No. 1, and also to No. 6 of the same sheet.

E. By chapels formed by four niches:

Pl. LXXXIV, No. 7 (the circular plan on the left below) shows this arrangement in which the central dome has become circular inside and might therefore be classed after this group. [Footnote 1: This plan and some others of this class remind us of the plan of the Mausoleum of Augustus as it is represented for instance by Durand. See Cab. des Estampes, Bibliotheque Nationale, Paris, Topographie de Rome, V, 6, 82.]

The sketch on the right hand side gives most likely the elevation for the last named plan.

F. By chapels of still richer combinations, which necessitate an octagon of larger dimensions:

Pl. XCI, No. 2 (MS. Ash. 11. 8b) [Footnote 2: The note accompanying this plan is given under No. 754.]; on this plan the chapels themselves appear to be central buildings formed like the first type of the third group. Pl. LXXXVIII, No. 3.

Pl. XCI, No. 2 above; the exterior of the preceding figure, particularly interesting on account of the alternation of apses and niches, the latter containing statues of a gigantic size, in proportion to the dimension of the niches.

b. Second Class.

Composite plans of this class are generally obtained by combining two types of the first class — the one worked out on the principal axes, the other on the diagonal ones.

MS. B. 22 shows an elementary combination, without any additions on the

diagonal axes, but with the dimensions of the squares on the two principal axes exceeding those of the sides of the octagon.

In the drawing W. P. 5b (see page 44 Fig. 1) the exterior only of the edifice is octagonal, the interior being formed by a circular colonnade; round chapels are placed against the four sides of the principal axes.

The elevation, drawn on the same sheet (see page 47 Fig. 3), shows the whole arrangement which is closely related with the one on Pl. LXXXVI No. 1, 2.

MS. B. 21a shows:

a) four sides with rectangular chapels crowned by pediments Pl. LXXXVII No. 3 (plan and elevation);

b) four sides with square chapels crowned by octagonal domes. Pl. LXXXVII No. 4; the plan underneath.

MS. B. 18a shows a variation obtained by replacing the round chapels in the principal axes of the sketch MS. B. 18a by square ones, with an apse. Leonardo repeated both ideas for better comparison side by side, see page 47. Fig. 2.

Pl. LXXXIX (MS. B. 17b). Elevation for the preceding figure. The comparison of the drawing marked M with the plan on page 47 Fig. 2, bearing the same mark, and of the elevation on Pl. LXXXIX below (marked A) with the corresponding plan on page 47 is highly instructive, as illustrating the spirit in which Leonardo pursued these studies.

Pl. LXXXIV No. 12 shows the design Pl. LXXXVII No. 3 combined with apses, with the addition of round chapels on the diagonal sides.

Pl. LXXXIV No. 13 is a variation of the preceding sketch.

Pl. XC No. 3. MS. B. 25b. The round chapels of the preceding sketch are replaced by octagonal chapels, above which rise campaniles.

Pl. XC No. 4 is the elevation for the preceding plan.

Pl. XCII No. 1. (MS. B. 39b.); the plan below. On the principal as well as on the diagonal axes are diagonal chapels, but the latter are separated from the dome by semicircular recesses. The communication between these eight chapels forms a square aisle round the central dome.

Above this figure is the elevation, showing four campaniles on the angles. [Footnote 1: The note accompanying this drawing is reproduced under No. 753.]

Pl. LXXXIV No. 3. On the principal axes are square chapels with three niches; on the diagonals octagonal chapels with niches. Cod. Atl. 340b gives a somewhat similar arrangement.

MS. B. 30. The principal development is thrown on the diagonal axes by square chapels with three niches; on the principal axes are inner recesses communicating with outer ones.

The plan Pl. XCIII No. 2 (MS. B. 22) differs from this only in so far as the

outer semicircles have become circular chapels, projecting from the external square as apses; one of them serves as the entrance by a semicircular portico.

The elevation is drawn on the left side of the plan.

MS. B. 19. A further development of MS. B. 18, by employing for the four principal chapels the type Pl. LXXXVIII No. 3, as we have already seen in Pl. XCI No. 2; the exterior presents two varieties.

a) The outer contour follows the inner. [Footnote 2: These chapels are here sketched in two different sizes; it is the smaller type which is thus formed.]

b) It is semicircular.

Pl. LXXXVII No. 2 (MS. B. 18b) Elevation to the first variation MS. B. 19. If we were not certain that this sketch was by Leonardo, we might feel tempted to take it as a study by Bramante for St. Peter's at Rome. [Footnote 3: See *Les projets primitifs* Pl. 43.]

MS. P. V. 39b. In the principal axes the chapels of MS. B. 19, and semicircular niches on the diagonals. The exterior of the whole edifice is also an octagon, concealing the form of the interior chapels, but with its angles on their axes.

Group V.

Suggested by San Lorenzo at Milan.

In MS. C. A. 266 IIb, 812b there is a plan almost identical with that of San Lorenzo. The diagonal sides of the irregular octagon are not indicated.

If it could be proved that the arches which, in the actual church, exist on these sides in the first story, were added in 1574 by Martimo Bassi, then this plan and the following section would be still nearer the original state of San Lorenzo than at present. A reproduction of this slightly sketched plan has not been possible. It may however be understood from Pl. LXXXVIII No. 3, by suppressing the four pillars corresponding to the apses.

Pl. LXXXVII No. 1 shows the section in elevation corresponding with the above-named plan. The recessed chapels are decorated with large shells in the halfdomes like the arrangement in San Lorenzo, but with proportions like those of Bramante's Sacristy of Santa Maria presso S. Satiro.

MS. C. A. 266; a sheet containing three views of exteriors of Domes. On the same sheet there is a plan similar to the one above-named but with uninterrupted aisles and with the addition of round chapels in the axes (compare Pl. XCVII No. 3 and page 44 Fig. 1), perhaps a reminiscence of the two chapels annexed to San Lorenzo. — Leonardo has here sketched the way of transforming this plan into a Latin cross by means of a nave with side aisles.

Pl. XCI No. 1. Plan showing a type deprived of aisles and comprised in a square building which is surrounded by a portico. It is accompanied by the

following text:

756.

This edifice is inhabited [accessible] below and above, like San Sepolcro, and it is the same above as below, except that the upper story has the dome *c d*; and the [Footnote: The church of San Sepolcro at Milan, founded in 1030 and repeatedly rebuilt after the middle of the XVIth century, still stands over the crypt of the original structure.] lower has the dome *a b*, and when you enter into the crypt, you descend 10 steps, and when you mount into the upper you ascend 20 steps, which, with 1/3 braccio for each, make 10 braccia, and this is the height between one floor of the church and the other.

Above the plan on the same sheet is a view of the exterior. By the aid of these two figures and the description, sections of the edifice may easily be reconstructed. But the section drawn on the left side of the building seems not to be in keeping with the same plan, notwithstanding the explanatory note written underneath it: “dentro il difitio di sopra” (interior of the edifice above)[Footnote 1: *The small inner dome corresponds to a b on the plan — it rises from the lower church into the upper — above, and larger, rises the dome c d. The aisles above and below thus correspond (e di sopra come di sotto, salvoche etc.). The only difference is, that in the section Leonardo has not taken the trouble to make the form octagonal, but has merely sketched circular lines in perspective. J. P. R.*].

Before leaving this group, it is well to remark that the germ of it seems already indicated by the diagonal lines in the plans Pl. LXXXV No. 11 and No. 7. We shall find another application of the same type to the Latin cross in Pl. XCVII No. 3.

2. Churches formed on the plan of a Latin cross.

We find among Leonardo's studies several sketches for churches on the plan of the Latin cross; we shall begin by describing them, and shall add a few observations.

A. Studies after existing Monuments.

Pl. XCIV No. 2. (MS. B. 11b.) Plan of Santo Spirito at Florence, a basilica built after the designs of Brunellesco. — Leonardo has added the indication of a portico in front, either his own invention or the reproduction of a now lost design.

Pl. XCV No. 2. Plan accompanied by the words: “A e santo sepolcro di milano di sopra”(A is the upper church of S. Sepolcro at Milan); although since Leonardo's time considerably spoilt, it is still the same in plan.

The second plan with its note: “B e la sua parte socto tera” (B is its subterranean part [the crypt]) still corresponds with the present state of this part of the church as I have ascertained by visiting the crypt with this plan. Excepting the addition of a few insignificant walls, the state of this interesting part of the church still conforms to Leonardo’s sketch; but in the Vestibolo the two columns near the entrance of the winding stairs are absent.

B. Designs or Studies.

PL. XCV No. 1. Plan of a church evidently suggested by that of San Sepolcro at Milan. The central part has been added to on the principle of the second type of Group III. Leonardo has placed the “coro” (*choir*) in the centre.

Pl. XCVI No. 2. In the plan the dome, as regards its interior, belongs to the First Class of Group IV, and may be grouped with the one in MS. B. 35a. The nave seems to be a development of the type represented in Pl. XCV No. 2, B. by adding towers and two lateral porticos[Footnote 1: Already published in *Les projets primitifs* Pl. XLIII.].

On the left is a view of the exterior of the preceding plan. It is accompanied by the following note:

757.

This building is inhabited below and above; the way up is by the campaniles, and in going up one has to use the platform, where the drums of the four domes are, and this platform has a parapet in front, and none of these domes communicate with the church, but they are quite separate.

Pl. XCVI No. 1 (MS. C. A. 16b; 65a). Perspective view of a church seen from behind; this recalls the Duomo at Florence, but with two campaniles[Footnote 2: Already published in the *Saggio* Pl. IX.].

Pl. XCVII No. 3 (MS. B. 52a). The central part is a development of S. Lorenzo at Milan, such as was executed at the Duomo of Pavia. There is sufficient analogy between the building actually executed and this sketch to suggest a direct connection between them. Leonardo accompanied Francesco di Giorgio[Footnote 3: See MALASPINA, *il Duomo di Pavia. Documents.*] when the latter was consulted on June 21st, 1490 as to this church; the fact that the only word accompanying the plan is: “sagrestia”, seems to confirm our supposition, for the sacristies were added only in 1492, i. e. four years after the beginning of the Cathedral, which at that time was most likely still sufficiently unfinished to be capable of receiving the form of the present sketch.

Pl. XCVII No. 2 shows the exterior of this design. Below is the note: *edifitio*

al proposito del fodameto figurato di socto (edifice proper for the ground plan figured below).

Here we may also mention the plan of a Latin cross drawn in MS. C.

A. fol. 266 (see p. 50).

Pl. XCIV No. 1 (MS. L. 15b). External side view of Brunellesco's Florentine basilica San Lorenzo, seen from the North.

Pl. XCIV No. 4 (V. A. V, 1). Principal front of a nave, most likely of a church on the plan of a Latin cross. We notice here not only the principal features which were employed afterwards in Alberti's front of S. Maria Novella, but even details of a more advanced style, such as we are accustomed to meet with only after the year 1520.

In the background of Leonardo's unfinished picture of St. Jerome (Vatican Gallery) a somewhat similar church front is indicated (see the accompanying sketch).

[Illustration with caption: The view of the front of a temple, apparently a dome in the centre of four corinthian porticos bearing pediments (published by Amoretti Tav. II. B as being by Leonardo), is taken from a drawing, now at the Ambrosian Gallery. We cannot consider this to be by the hand of the master.]

C. Studies for a form of a Church most proper for preaching.

The problem as to what form of church might answer the requirements of acoustics seems to have engaged Leonardo's very particular attention. The designation of "teatro" given to some of these sketches, clearly shows which plan seemed to him most favourable for hearing the preacher's voice.

Pl. XCVII, No. 1 (MS. B, 52). Rectangular edifice divided into three naves with an apse on either side, terminated by a semicircular theatre with rising seats, as in antique buildings. The pulpit is in the centre. Leonardo has written on the left side of the sketch: "teatro da predicare" (Theatre for preaching).

MS. B, 55a (see page 56, Fig. 1). A domed church after the type of Pl. XCV, No. 1, shows four theatres occupying the apses and facing the square "coro" (choir), which is in the centre between the four pillars of the dome.[Footnote 1: The note teatro de predicar, on the right side is, I believe, in the handwriting of Pompeo Leoni. J. P. R.] The rising arrangement of the seats is shown in the sketch above. At the place marked B Leonardo wrote teatri per uldire messa (rows of seats to hear mass), at T teatri, and at C coro (choir).

In MS. C.A. 260, are slight sketches of two plans for rectangular choirs and two elevations of the altar and pulpit which seem to be in connection with these plans.

In MS. Ash II, 8a (see p. 56 and 57. Fig. 2 and 3). "Locho dove si predica" (Place for preaching). A most singular plan for a building. The interior is a

portion of a sphere, the centre of which is the summit of a column destined to serve as the preacher's pulpit. The inside is somewhat like a modern theatre, whilst the exterior and the galleries and stairs recall the ancient amphitheatres.

[Illustration with caption: Page 57, Fig. 4. A plan accompanying the two preceding drawings. If this gives the complete form Leonardo intended for the edifice, it would have comprised only about two thirds of the circle. Leonardo wrote in the centre "*fondamento*", a word he often employed for plans, and on the left side of the view of the exterior: *locho dove si predicha (a place for preaching in).*]

D. Design for a Mausoleum.

Pl. XCVIII (P. V., 182. No. d'ordre 2386). In the midst of a hilly landscape rises an artificial mountain in the form of a gigantic cone, crowned by an imposing temple. At two thirds of the height a terrace is cut out with six doorways forming entrances to galleries, each leading to three sepulchral halls, so constructed as to contain about five hundred funeral urns, disposed in the customary antique style. From two opposite sides steps ascend to the terrace in a single flight and beyond it to the temple above. A large circular opening, like that in the Pantheon, is in the dome above what may be the altar, or perhaps the central monument on the level of the terrace below.

The section of a gallery given in the sketch to the right below shows the roof to be constructed on the principle of superimposed horizontal layers, projecting one beyond the other, and each furnished with a sort of heel, which appears to be undercut, so as to give the appearance of a beam from within. Granite alone would be adequate to the dimensions here given to the key stone, as the thickness of the layers can hardly be considered to be less than a foot. In taking this as the basis of our calculation for the dimensions of the whole construction, the width of the chamber would be about 25 feet but, judging from the number of urns it contains — and there is no reason to suppose that these urns were larger than usual — it would seem to be no more than about 8 or 10 feet.

The construction of the vaults resembles those in the galleries of some etruscan tumuli, for instance the Regolini Galeassi tomb at Cervetri (lately discovered) and also that of the chamber and passages of the pyramid of Cheops and of the treasury of Atreus at Mycenae.

The upper cone displays not only analogies with the monuments mentioned in the note, but also with Etruscan tumuli, such as the Cocumella tomb at Vulci, and the Regolini Galeassi tomb[Footnote 1: See FERSGUSON, *Handbook of Architecture*, I, 291.]. The whole scheme is one of the most magnificent in the history of Architecture.

It would be difficult to decide as to whether any monument he had seen

suggested this idea to Leonardo, but it is worth while to enquire, if any monument, or group of monuments of an earlier date may be supposed to have done so.[Footnote 2: *There are, in Algiers, two Monuments, commonly called "Le Madracen" and "Le tombeau de la Chretienne," which somewhat resemble Leonardo's design. They are known to have served as the Mausolea of the Kings of Mauritania. Pomponius Mela, the geographer of the time of the Emperor Claudius, describes them as having been "Monumentum commune regiae gentis."* See *Le Madracen*, Rapport fait par M. le Grand Rabbin AB. CAHEN, Constantine 1873 — *Memoire sur les fouilles executees au Madras'en .. par le Colonel BRUNON*, Constantine 1873. — *Deux Mausolees Africains, le Madracen et le tombeau de la Chretienne* par M. J. DE LAURIERE, Tours 1874. — *Le tombeau de la Chretienne, Mausolee des rois Mauritanien*s par M. BERBRUGGER, Alger 1867. — *I am indebted to M. LE BLANC, of the Institut, and M. LUD, LALANNE, Bibliothecaire of the Institut for having first pointed out to me the resemblance between these monuments; while M. ANT. HERON DE VILLEFOSSE of the Louvre was kind enough to place the abovementioned rare works at my disposal. Leonardo's observations on the coast of Africa are given later in this work. The Herodium near Bethlehem in Palestine (Jebel el Fureidis, the Frank Mountain) was, according to the latest researches, constructed on a very similar plan. See Der Frankenberg, von Baurath C. SCHICK in Jerusalem, Zeitschrift des Deutschen Palastina-Vereins, Leipzig 1880, Vol. III, pages 88-99 and Plates IV and V. J. P. R.]*

E. Studies for the Central Tower, or Tiburio of Milan Cathedral.

Towards the end of the fifteenth century the Fabbricceria del Duomo had to settle on the choice of a model for the crowning and central part of this vast building. We learn from a notice published by G. L. Calvi [Footnote: G. L. CALVI, *Notizie sulla vita e sulle opere dei principali architetti scultori e pittori che fiorirono in Milano*, Part III, 20. See also: H. DE GEYMULLER, *Les projets primitifs etc.* I, 37 and 116-119. — The Fabbricceria of the Duomo has lately begun the publication of the archives, which may possibly tell us more about the part taken by Leonardo, than has hitherto been known.] that among the artists who presented models in the year 1488 were: Bramante, Pietro da Gorgonzola, Luca Paperio (Fancelli), and Leonardo da Vinci. —

Several sketches by Leonardo refer to this important project:

Pl. XCIX, No. 2 (MS. S. K. III, No. 36a) a small plan of the whole edifice. — The projecting chapels in the middle of the transept are wanting here. The nave appears to be shortened and seems to be approached by an inner "vestibolo". —

Pl. C, No. 2 (Tr. 21). Plan of the octagon tower, giving the disposition of the buttresses; starting from the eight pillars adjoining the four principal piers and

intended to support the eight angles of the Tiburio. These buttresses correspond exactly with those described by Bramante as existing in the model presented by Omodeo. [Footnote: Bramante's opinion was first published by G. MONGERI, Arch. stor. Lomb. V, fasc. 3 and afterwards by me in the publication mentioned in the preceding note.]

Pl. C, 3 (MS. Tr. 16). Two plans showing different arrangements of the buttresses, which seem to be formed partly by the intersection of a system of pointed arches such as that seen in **

Pl. C, No. 5 (MS. B, 27a) destined to give a broader base to the drum. The text underneath is given under No. 788.

MS. B, 3 — three slight sketches of plans in connexion with the preceding ones.

Pl. XCIX, No.1 (MS. Tr. 15) contains several small sketches of sections and exterior views of the Dome; some of them show buttress-walls shaped as inverted arches. Respecting these Leonardo notes:

758.

L'arco rivescio e migliore per fare spalla che l'ordinario, perche il rovescio trova sotto se muro resistete alla sua debolezza, e l'ordinario no trova nel suo debole se non aria

The inverted arch is better for giving a shoulder than the ordinary one, because the former finds below it a wall resisting its weakness, whilst the latter finds in its weak part nothing but air.

[Footnote: Three slight sketches of sections on the same leaf — above those reproduced here — are more closely connected with the large drawing in the centre of Pl. C, No. 4 (M.S, Tr. 41) which shows a section of a very elevated dome, with double vaults, connected by ribs and buttresses ingeniously disposed, so as to bring the weight of the lantern to bear on the base of the dome.

A sketch underneath it shows a round pillar on which is indicated which part of its summit is to bear the weight: "il pilastro sara charicho in . a . b." (The column will bear the weight at a b.) Another note is above on the right side: *Larcho regiera tanto sotto asse chome di sopra se* (The arch supports as much below it [i. e. a hanging weight] as above it).

Pl. C, No. 1 (C. A. 303a). Larger sketch of half section of the

Dome, with a very complicated system of arches, and a double vault.

Each stone is shaped so as to be knit or dovetailed to its

neighbours. Thus the inside of the Dome cannot be seen from below.

MS. C. A. 303b. A repetition of the preceding sketch with very slight modifications.]

[Figs. 1. and Fig. 2. two sketeches of the dome]

MS. Tr. 9 (see Fig. 1 and 2). Section of the Dome with reverted buttresses between the windows, above which iron anchors or chains seem to be intended. Below is the sketch of the outside.

PI. XCIX, No. 3 (C. A., 262a) four sketches of the exterior of the Dome.

C. A. 12. Section, showing the points of rupture of a gothic vault, in evident connection with the sketches described above.

It deserves to be noticed how easily and apparently without effort, Leonardo manages to combine gothic details and structure with the more modern shape of the Dome.

The following notes are on the same leaf, *oni cosa poderosa, and oni cosa poderosa desidera de(scendere); farther below, several multiplications most likely intended to calculate the weight of some parts of the Dome, thus $16 \times 47 = 720$; $720 \times 800 = 176000$, next to which is written: peso del pilastro di 9 teste (weight of the pillar 9 diameters high).*

Below: $176000 \times 8 = 1408000$; and below:

Semjlio e se ce 80 (?) il peso del tiburio (six millions six hundred (?) 80 the weight of the Dome).

Bossi hazarded the theory that Leonardo might have been the architect who built the church of Sta. Maria delle Grazie, but there is no evidence to support this, either in documents or in the materials supplied by Leonardos manuscripts and drawings. The sketch given at the side shows the arrangement of the second and third socle on the apses of the choir of that church; and it is remarkable that those sketches, in MS. S. K. M. II2, 2a and Ib, occur with the passage given in Volume I as No. 665 and 666 referring to the composition of the Last Supper in the Refectory of that church.]

F. The Project for lifting up the Battistero of Florence and setting it on a basement.

Among the very few details Vasari gives as to the architectural studies of Leonardo, we read: "And among these models and designs there was one by way of which he showed several times to many ingenious citizens who then governed Florence, his readiness to lift up without ruining it, the church of San Giovanni in Florence (the Battistero, opposite the Duomo) in order to place under it the missing basement with steps; he supported his assertions with reasons so persuasive, that while he spoke the undertaking seemed feasible, although every one of his hearers, when he had departed, could see by himself the impossibility of so vast an undertaking."

[Footnote: *This latter statement of Vasari's must be considered to be exaggerated. I may refer here to some data given by LIBRI, Histoire des sciences mathematiques en Italie (II, 216, 217): "On a cru dans ces derniers temps faire un miracle en mecanique en effectuant ce transport, et cependant des l'annee 1455, Gaspard Nadi et Aristote de Fioravantio avaient transporte, a une distance considerable, la tour de la Magione de Bologne, avec ses fondements, qui avait presque quatre-vingts pieds de haut. Le continuateur de la chronique de Pugliola dit que le trajet fut de 35 pieds et que durant le transport auquel le chroniqueur affirme avoir assiste, il arriva un accident grave qui fit pencher de trois pieds la tour pendant qu'elle etait suspendue, mais que cet accident fut promptement repare (Muratori, Scriptores rer. ital. Tom. XVIII, col. 717, 718). Alidosi a rapporte une note ou Nadi rend compte de ce transport avec une rare simplicité. D'après cette note, on voit que les operations de ce genre n'étaient pas nouvelles. Celle-ci ne couta que 150 livres (monnaie d'alors) y compris le cadeau que le Legat fit aux deux mecaniciens. Dans la meme annee, Aristote redressa le clocher de Cento, qui penchait de plus de cinq pieds (Alidosi, instruttione p. 188 — Muratori, Scriptores rer. ital., tom. XXIII, col. 888. — Bossii, chronica Mediol., 1492, in-fol. ad ann. 1455). On ne concoit pas comment les historiens des beaux-arts ont pu negliger de tels hommes."* J. P. R.]

In the MS. C. A. fol. 293, there are two sketches which possibly might have a bearing on this bold enterprise. We find there a plan of a circular or polygonal edifice surrounded by semicircular arches in an oblique position. These may be taken for the foundation of the steps and of the new platform. In the perspective elevation the same edifice, forming a polygon, is shown as lifted up and resting on a circle of inverted arches which rest on an other circle of arches in the ordinary position, but so placed that the inverted arches above rest on the spandrels of the lower range.

What seems to confirm the supposition that the lifting up of a building is here in question, is the indication of engines for winding up, such as jacks, and a rack and wheel. As the lifting apparatus represented on this sheet does not seem particularly applicable to an undertaking of such magnitude, we may consider it to be a first sketch or scheme for the engines to be used.

G. Description of an unknown Temple.

759.

Twelve flights of steps led up to the great temple, which was eight hundred braccia in circumference and built on an octagonal plan. At the eight corners

were eight large plinths, one braccia and a half high, and three wide, and six long at the bottom, with an angle in the middle; on these were eight great pillars, standing on the plinths as a foundation, and twenty four braccia high. And on the top of these were eight capitals three braccia long and six wide, above which were the architrave frieze and cornice, four braccia and a half high, and this was carried on in a straight line from one pillar to the next and so, continuing for eight hundred braccia, surrounded the whole temple, from pillar to pillar. To support this entablature there were ten large columns of the same height as the pillars, three braccia thick above their bases which were one braccia and a half high.

The ascent to this temple was by twelve flights of steps, and the temple was on the twelfth, of an octagonal form, and at each angle rose a large pillar; and between the pillars were placed ten columns of the same height as the pillars, rising at once from the pavement to a height of twenty eight braccia and a half; and at this height the architrave, frieze and cornice were placed which surrounded the temple having a length of eight hundred braccia. At the same height, and within the temple at the same level, and all round the centre of the temple at a distance of 24 braccia farther in, are pillars corresponding to the eight pillars in the angles, and columns corresponding to those placed in the outer spaces. These rise to the same height as the former ones, and over these the continuous architrave returns towards the outer row of pillars and columns.

[Footnote: Either this description is incomplete, or, as seems to me highly probable, it refers to some ruin. The enormous dimensions forbid our supposing this to be any temple in Italy or Greece. Syria was the native land of colossal octagonal buildings, in the early centuries A. D. The Temple of Baalbek, and others are even larger than that here described. J. P. R.]

V. Palace architecture.

But a small number of Leonardo's drawings refer to the architecture of palaces, and our knowledge is small as to what style Leonardo might have adopted for such buildings.

Pl. CII No. 1 (W. XVIII). A small portion of a facade of a palace in two stories, somewhat resembling Alberti's Palazzo Rucellai. — Compare with this Bramante's painted front of the Casa Silvestri, and a painting by Montorfano in San Pietro in Gessate at Milan, third chapel on the left hand side and also with Bramante's palaces at Rome. The pilasters with arabesques, the rustica between them, and the figures over the window may be painted or in sgraffito. The original is drawn in red chalk.

Pl. LXXXI No. 1 (MS. Tr. 42). Sketch of a palace with battlements and decorations, most likely graffiti; the details remind us of those in the Castello at

Vigevano. [Footnote 1: Count GIULIO PORRO, in his valuable contribution to the Archivio Storico Lombardo, Anno VIII, Fasc. IV (31 Dec. 1881): Leonardo da Vinci, Libro di Annotazioni e Memorie, refers to this in the following note: "Alla pag. 41 vi e uno schizzo di volta ed accanto scrisse: 'il pilastro sara charicho in su 6' e potrebbe darsi che si riferisse alla cupola della chiesa delle Grazie tanto piu che a pag. 42 vi e un disegno che rassomiglia assai al basamento che oggi si vede nella parte esterna del coro di quella chiesa." *This may however be doubted. The drawing, here referred to, on page 41 of the same manuscript, is reproduced on Pl. C No. 4 and described on page 61 as being a study for the cupola of the Duomo of Milan. J. P. R.*]

MS. Mz. 0", contains a design for a palace or house with a loggia in the middle of the first story, over which rises an attic with a Pediment reproduced on page 67. The details drawn close by on the left seem to indicate an arrangement of coupled columns against the wall of a first story.

Pl. LXXXV No. 14 (MS. S. K. M. Ill 79a) contains a very slight sketch in red chalk, which most probably is intended to represent the facade of a palace. Inside is the short note *7 he 7* (7 and 7).

MS. J2 8a (see pages 68 Fig. 1 and 2) contains a view of an unknown palace. Its plan is indicated at the side.

In MS. Br. M. 126a(see Fig. 3 on page 68) there is a sketch of a house, on which Leonardo notes; *casa con tre terrazi* (house with three terraces).

Pl. CX, No. 4 (MS. L. 36b) represents the front of a fortified building drawn at Cesena in 1502 (see No. 1040).

Here we may also mention the singular building in the allegorical composition represented on Pl. LVIII in Vol. I. In front of it appears the head of a sphinx or of a dragon which seems to be carrying the palace away.

The following texts refer to the construction of palaces and other buildings destined for private use:

760.

In the courtyard the walls must be half the height of its width, that is if the court be 40 braccia, the house must be 20 high as regards the walls of the said courtyard; and this courtyard must be half as wide as the whole front.

[Footnote: See Pl. CI, no. 1, and compare the dimensions here given, with No. 748 lines 26-29; and the drawing belonging to it Pl. LXXXI, no. 2.]

On the dispositions of a stable.

761.

FOR MAKING A CLEAN STABLE.

The manner in which one must arrange a stable. You must first divide its width in 3 parts, its depth matters not; and let these 3 divisions be equal and 6 braccia broad for each part and 10 high, and the middle part shall be for the use of the stablemasters; the 2 side ones for the horses, each of which must be 6 braccia in width and 6 in length, and be half a braccio higher at the head than behind. Let the manger be at 2 braccia from the ground, to the bottom of the rack, 3 braccia, and the top of it 4 braccia. Now, in order to attain to what I promise, that is to make this place, contrary to the general custom, clean and neat: as to the upper part of the stable, i. e. where the hay is, that part must have at its outer end a window 6 braccia high and 6 broad, through which by simple means the hay is brought up to the loft, as is shown by the machine *E*; and let this be erected in a place 6 braccia wide, and as long as the stable, as seen at *k p*. The other two parts, which are on either side of this, are again divided; those nearest to the hay-loft are 4 braccia, *p s*, and only for the use and circulation of the servants belonging to the stable; the other two which reach to the outer walls are 2 braccia, as seen at *s k*, and these are made for the purpose of giving hay to the mangers, by means of funnels, narrow at the top and wide over the manger, in order that the hay should not choke them. They must be well plastered and clean and are represented at *4 f s*. As to the giving the horses water, the troughs must be of stone and above them [cisterns of] water. The mangers may be opened as boxes are uncovered by raising the lids. [Footnote: See Pl. LXXVIII, No.1.]

Decorations for feasts.

762.

THE WAY TO CONSTRUCT A FRAMEWORK FOR DECORATING BUILDINGS.

The way in which the poles ought to be placed for tying bunches of juniper on to them. These poles must lie close to the framework of the vaulting and tie the bunches on with osier withes, so as to clip them even afterwards with shears.

Let the distance from one circle to another be half a braccia; and the juniper [sprigs] must lie top downwards, beginning from below.

Round this column tie four poles to which willows about as thick as a finger must be nailed and then begin from the bottom and work upwards with bunches of juniper sprigs, the tops downwards, that is upside down. [Footnote: See Pl. CII, No. 3. The words here given as the title line, lines 1 — 4, are the last in the original MS. — Lines 5 — 16 are written under fig. 4.]

763.

The water should be allowed to fall from the whole circle *a b*.

[Footnote: Other drawings of fountains are given on Pl. CI (W. XX); the original is a pen and ink drawing on blue paper; on Pl. CIII (MS. B.) and Pl. LXXXII.]

VI. *Studies of architectural details.*

Several of Leonardo's drawings of architectural details prove that, like other great masters of that period, he had devoted his attention to the study of the proportion of such details. As every organic being in nature has its law of construction and growth, these masters endeavoured, each in his way, to discover and prove a law of proportion in architecture. The following notes in Leonardo's manuscripts refer to this subject.

MS. S. K. M. Ill, 47b (see Fig. 1). A diagram, indicating the rules as given by Vitruvius and by Leon Battista Alberti for the proportions of the Attic base of a column.

MS. S. K. M. Ill 55a (see Fig. 2). Diagram showing the same rules.

764.

B toro superiore toro superiore 2B nestroli astragali quadre 3B orbiculo troclea 4B nestroli astragali quadre 5B toro iferiore toro iferiore 6B latastro plintho

[Footnote: No explanation can be offered of the meaning of the letter B, which precedes each name. It may be meant for *basa* (base). Perhaps it refers to some author on architecture or an architect (Bramante?) who employed the designations, thus marked for the mouldings. 3. *troclea*. Philander: *Trochlea sive trochalia aut rechanum*. 6. *Laterculus* or *latastrum* is the Latin name for *Plinthus* (pi lambda Xiv) but Vitruvius adopted this Greek name and “latastro”

seems to have been little in use. It is to be found besides the text given above, as far as I am aware, only two drawings of the Uffizi Collection, where in one instance, it indicates the *abacus* of a Doric capital.]

765.

STEPS OF URRBINO.

The plinth must be as broad as the thickness of the wall against which the plinth is built. [Footnote: See Pl. CX No. 3. The hasty sketch on the right hand side illustrates the unsatisfactory effect produced when the plinth is narrower than the wall.]

766.

The ancient architects beginning with the Egyptians (?) who, as Diodorus Siculus writes, were the first to build and construct large cities and castles, public and private buildings of fine form, large and well proportioned

The column, which has its thickness at the third part The one which would be thinnest in the middle, would break ...; the one which is of equal thickness and of equal strength, is better for the edifice. The second best as to the usefulness will be the one whose greatest thickness is where it joins with the base.

[Footnote: See Pl. CIII, No. 3, where the sketches belonging to lines 10 — 16 are reproduced, but reversed. The sketch of columns, here reproduced by a wood cut, stands in the original close to lines 5 — 8.]

The capital must be formed in this way. Divide its thickness at the top into 8; at the foot make it $\frac{5}{7}$, and let it be $\frac{5}{7}$ high and you will have a square; afterwards divide the height into 8 parts as you did for the column, and then take $\frac{1}{8}$ for the echinus and another eighth for the thickness of the abacus on the top of the capital. The horns of the abacus of the capital have to project beyond the greatest width of the bell $\frac{2}{7}$, i. e. sevenths of the top of the bell, so $\frac{1}{7}$ falls to the projection of each horn. The truncated part of the horns must be as broad as it is high. I leave the rest, that is the ornaments, to the taste of the sculptors. But to return to the columns and in order to prove the reason of their strength or weakness according to their shape, I say that when the lines starting from the

summit of the column and ending at its base and their direction and length ..., their distance apart or width may be equal; I say that this column ...

767.

The cylinder of a body columnar in shape and its two opposite ends are two circles enclosed between parallel lines, and through the centre of the cylinder is a straight line, ending at the centre of these circles, and called by the ancients the axis.

[Footnote: Leonardo wrote these lines on the margin of a page of the Trattato di Francesco di Giorgio, where there are several drawings of columns, as well as a head drawn in profile inside an outline sketch of a capital.]

768.

$a b$ is $\frac{1}{3}$ of $n m$; $m o$ is $\frac{1}{6}$ of $r o$. The ovolo projects $\frac{1}{6}$ of $r o$; s $\frac{7}{5}$ of $r o$, $a b$ is divided into $9 \frac{1}{2}$; the abacus is $\frac{3}{9}$ the ovolo $\frac{4}{9}$, the bead-moulding and the fillet $\frac{2}{9}$ and $\frac{1}{2}$.

[Footnote: See Pl. LXXXV, No. 16. In the original the drawing and writing are both in red chalk.]

Pl. LXXXV No. 6 (MS. Ash. II 6b) contains a small sketch of a capital with the following note, written in three lines: *I chorni del capitelo deono essere la quarta parte d'uno quadro (The horns of a capital must measure the fourth part of a square).*

MS. S. K. M. III 72b contains two sketches of ornamentations of windows.

In MS. C. A. 308a; 938a (see Pl. LXXXII No. 1) there are several sketches of columns. One of the two columns on the right is similar to those employed by Bramante at the Canonica di S. Ambrogio. The same columns appear in the sketch underneath the plan of a castle. There they appear coupled, and in two stories one above the other. The archivolls which seem to spring out of the columns, are shaped like twisted cords, meant perhaps to be twisted branches. The walls between the columns seem to be formed out of blocks of wood, the pedestals are ornamented with a reticulated pattern. From all this we may suppose that Leonardo here had in mind either some festive decoration, or perhaps a pavilion for some hunting place or park. The sketch of columns marked "35" gives an example of columns shaped like candelabra, a form often employed at that time, particularly in Milan, and the surrounding districts for

instance in the Cortile di Casa Castiglione now Silvestre, in the cathedral of Como, at Porta della Rana &c.

769.

CONCERNING ARCHITRAVES OF ONE OR SEVERAL PIECES.

An architrave of several pieces is stronger than that of one single piece, if those pieces are placed with their length in the direction of the centre of the world. This is proved because stones have their grain or fibre generated in the contrary direction i. e. in the direction of the opposite horizons of the hemisphere, and this is contrary to fibres of the plants which have ...

[Footnote: The text is incomplete in the original.]

The Proportions of the stories of a building are indicated by a sketch in MS. S. K. M. II2 11b (see Pl. LXXXV No. 15). The measures are written on the left side, as follows: br 1 1/2 — 6 3/4 — br 1/12 — 2 br — 9 e 1/2 — 1 1/2 — br 5 — o 9 — o 3 [br=braccia; o=oncie].

Pl. LXXXV No. 13 (MS. B. 62a) and Pl. XCIII No. 1. (MS. B. 15a) give a few examples of arches supported on piers.

XIII. THEORETICAL WRITINGS ON ARCHITECTURE.

Leonardo's original writings on the theory of Architecture have come down to us only in a fragmentary state; still, there seems to be no doubt that he himself did not complete them. It would seem that Leonardo entertained the idea of writing a large and connected book on Architecture; and it is quite evident that the materials we possess, which can be proved to have been written at different periods, were noted down with a more or less definite aim and purpose. They might all be collected under the one title: "Studies on the Strength of Materials". Among them the investigations on the subject of fissures in walls are particularly thorough, and very fully reported; these passages are also especially interesting, because Leonardo was certainly the first writer on architecture who ever treated the subject at all. Here, as in all other cases Leonardo carefully avoids all abstract argument. His data are not derived from the principles of algebra, but from the laws of mechanics, and his method throughout is strictly experimental.

Though the conclusions drawn from his investigations may not have that precision which we are accustomed to find in Leonardo's scientific labours, their interest is not lessened. They prove at any rate his deep sagacity and wonderfully clear mind. No one perhaps, who has studied these questions since Leonardo, has combined with a scientific mind anything like the artistic delicacy of perception which gives interest and lucidity to his observations.

I do not assert that the arrangement here adopted for the passages in question is that originally intended by Leonardo; but their distribution into five groups was suggested by the titles, or headings, which Leonardo himself prefixed to most of these notes. Some of the longer sections perhaps should not, to be in strict agreement with this division, have been reproduced in their entirety in the place where they occur. But the comparatively small amount of the materials we possess will render them, even so, sufficiently intelligible to the reader; it did not therefore seem necessary or desirable to subdivide the passages merely for the sake of strict classification.

The small number of chapters given under the fifth class, treating on the centre of gravity in roof-beams, bears no proportion to the number of drawings and studies which refer to the same subject. Only a small selection of these are

reproduced in this work since the majority have no explanatory text.

I.

ON FISSURES IN WALLS.

770.

First write the treatise on the causes of the giving way of walls and then, separately, treat of the remedies.

Parallel fissures constantly occur in buildings which are erected on a hill side, when the hill is composed of stratified rocks with an oblique stratification, because water and other moisture often penetrates these oblique seams carrying in greasy and slippery soil; and as the strata are not continuous down to the bottom of the valley, the rocks slide in the direction of the slope, and the motion does not cease till they have reached the bottom of the valley, carrying with them, as though in a boat, that portion of the building which is separated by them from the rest. The remedy for this is always to build thick piers under the wall which is slipping, with arches from one to another, and with a good scarp and let the piers have a firm foundation in the strata so that they may not break away from them.

In order to find the solid part of these strata, it is necessary to make a shaft at the foot of the wall of great depth through the strata; and in this shaft, on the side from which the hill slopes, smooth and flatten a space one palm wide from the top to the bottom; and after some time this smooth portion made on the side of the shaft, will show plainly which part of the hill is moving.

[Footnote: See Pl. CIV.]

771.

The cracks in walls will never be parallel unless the part of the wall that separates from the remainder does not slip down.

WHAT IS THE LAW BY WHICH BUILDINGS HAVE STABILITY.

The stability of buildings is the result of the contrary law to the two former cases. That is to say that the walls must be all built up equally, and by degrees, to equal heights all round the building, and the whole thickness at once, whatever kind of walls they may be. And although a thin wall dries more quickly than a thick one it will not necessarily give way under the added weight day by day and thus, although a thin wall dries more quickly than a thick one, it will not give way under the weight which the latter may acquire from day to day. Because if double the amount of it dries in one day, one of double the thickness will dry in two days or thereabouts; thus the small addition of weight will be balanced by the smaller difference of time .

The adversary says that *a* which projects, slips down.

And here the adversary says that *r* slips and not *c*.

HOW TO PROGNOSTICATE THE CAUSES OF CRACKS IN ANY SORT OF WALL.

The part of the wall which does not slip is that in which the obliquity projects and overhangs the portion which has parted from it and slipped down.

ON THE SITUATION OF FOUNDATIONS AND IN WHAT PLACES THEY ARE A CAUSE OF RUIN.

When the crevice in the wall is wider at the top than at the bottom, it is a manifest sign, that the cause of the fissure in the wall is remote from the perpendicular line through the crevice.

[Footnote: Lines 1-5 refer to Pl. CV, No. 2. Line 9 *alle due anteciedete*, see on the same page.

Lines 16-18. The translation of this is doubtful, and the meaning in any case very obscure.

Lines 19-23 are on the right hand margin close to the two sketches on Pl. CII, No. 3.]

OF CRACKS IN WALLS, WHICH ARE WIDE AT THE BOTTOM AND NARROW AT THE TOP AND OF THEIR CAUSES.

That wall which does not dry uniformly in an equal time, always cracks.

A wall though of equal thickness will not dry with equal quickness if it is not everywhere in contact with the same medium. Thus, if one side of a wall were in contact with a damp slope and the other were in contact with the air, then this latter side would remain of the same size as before; that side which dries in the air will shrink or diminish and the side which is kept damp will not dry. And the dry portion will break away readily from the damp portion because the damp part not shrinking in the same proportion does not cohere and follow the movement of the part which dries continuously.

OF ARCHED CRACKS, WIDE AT THE TOP, AND NARROW BELOW.

Arched cracks, wide at the top and narrow below are found in walled-up doors, which shrink more in their height than in their breadth, and in proportion as their height is greater than their width, and as the joints of the mortar are more numerous in the height than in the width.

The crack diminishes less in ro than in mn , in proportion as there is less material between r and o than between n and m .

Any crack made in a concave wall is wide below and narrow at the top; and this originates, as is here shown at bcd , in the side figure.

1. That which gets wet increases in proportion to the moisture it imbibes.
2. And a wet object shrinks, while drying, in proportion to the amount of moisture which evaporates from it.

[Footnote: The text of this passage is reproduced in facsimile on Pl. CVI to the left. L. 36-40 are written inside the sketch No. 2. L. 41-46 are partly written over the sketch No. 3 to which they refer.]

OF THE CAUSES OF FISSURES IN [THE WALLS OF] PUBLIC AND PRIVATE BUILDINGS.

The walls give way in cracks, some of which are more or less vertical and others are oblique. The cracks which are in a vertical direction are caused by the joining of new walls, with old walls, whether straight or with indentations fitting on to those of the old wall; for, as these indentations cannot bear the too great weight of the wall added on to them, it is inevitable that they should break, and give way to the settling of the new wall, which will shrink one braccia in every ten, more or less, according to the greater or smaller quantity of mortar used between the stones of the masonry, and whether this mortar is more or less liquid. And observe, that the walls should always be built first and then faced with the stones intended to face them. For, if you do not proceed thus, since the wall settles more than the stone facing, the projections left on the sides of the wall must inevitably give way; because the stones used for facing the wall being larger than those over which they are laid, they will necessarily have less mortar laid between the joints, and consequently they settle less; and this cannot happen if the facing is added after the wall is dry.

a b the new wall, *c* the old wall, which has already settled; and the part *a b* settles afterwards, although *a*, being founded on *c*, the old wall, cannot possibly break, having a stable foundation on the old wall. But only the remainder *b* of the new wall will break away, because it is built from top to bottom of the building; and the remainder of the new wall will overhang the gap above the wall that has sunk.

774.

A new tower founded partly on old masonry.

775.

OF STONES WHICH DISJOIN THEMSELVES FROM THEIR MORTAR.

Stones laid in regular courses from bottom to top and built up with an equal quantity of mortar settle equally throughout, when the moisture that made the mortar soft evaporates.

By what is said above it is proved that the small extent of the new wall between *A* and *n* will settle but little, in proportion to the extent of the same wall between *c* and *d*. The proportion will in fact be that of the thinness of the mortar in relation to the number of courses or to the quantity of mortar laid between the stones above the different levels of the old wall.

[Footnote: See Pl. CV, No. 1. The top of the tower is wanting in this reproduction, and with it the letter *n* which, in the original, stands above the letter *A* over the top of the tower, while *c* stands perpendicularly over *d*.]

776.

This wall will break under the arch *e f*, because the seven whole square bricks are not sufficient to sustain the spring of the arch placed on them. And these seven bricks will give way in their middle exactly as appears in *a b*. The reason is, that the brick *a* has above it only the weight *a k*, whilst the last brick under the arch has above it the weight *c d x a*.

c d seems to press on the arch towards the abutment at the point *p* but the weight *p o* opposes resistance to it, whence the whole pressure is transmitted to the root of the arch. Therefore the foot of the arch acts like 7 6, which is more than double of *x z*.

II.

ON FISSURES IN NICHES.

777.

ON FISSURES IN NICHES.

An arch constructed on a semicircle and bearing weights on the two opposite

thirds of its curve will give way at five points of the curve. To prove this let the weights be at n m which will break the arch a , b , f . I say that, by the foregoing, as the extremities c and a are equally pressed upon by the thrust n , it follows, by the 5th, that the arch will give way at the point which is furthest from the two forces acting on them and that is the middle e . The same is to be understood of the opposite curve, d g b ; hence the weights n m must sink, but they cannot sink by the 7th, without coming closer together, and they cannot come together unless the extremities of the arch between them come closer, and if these draw together the crown of the arch must break; and thus the arch will give way in two places as was at first said &c.

I ask, given a weight at a what counteracts it in the direction n f and by what weight must the weight at f be counteracted.

778.

ON THE SHRINKING OF DAMP BODIES OF DIFFERENT THICKNESS AND WIDTH.

The window a is the cause of the crack at b ; and this crack is increased by the pressure of n and m which sink or penetrate into the soil in which foundations are built more than the lighter portion at b . Besides, the old foundation under b has already settled, and this the piers n and m have not yet done. Hence the part b does not settle down perpendicularly; on the contrary, it is thrown outwards obliquely, and it cannot on the contrary be thrown inwards, because a portion like this, separated from the main wall, is larger outside than inside and the main wall, where it is broken, is of the same shape and is also larger outside than inside; therefore, if this separate portion were to fall inwards the larger would have to pass through the smaller — which is impossible. Hence it is evident that the portion of the semicircular wall when disunited from the main wall will be thrust outwards, and not inwards as the adversary says.

When a dome or a half-dome is crushed from above by an excess of weight the vault will give way, forming a crack which diminishes towards the top and is wide below, narrow on the inner side and wide outside; as is the case with the outer husk of a pomegranate, divided into many parts lengthwise; for the more it is pressed in the direction of its length, that part of the joints will open most, which is most distant from the cause of the pressure; and for that reason the

arches of the vaults of any apse should never be more loaded than the arches of the principal building. Because that which weighs most, presses most on the parts below, and they sink into the foundations; but this cannot happen to lighter structures like the said apses.

[Footnote: The figure on Pl. CV, No. 4 belongs to the first paragraph of this passage, lines 1-14; fig. 5 is sketched by the side of lines 15 — and following. The sketch below of a pomegranate refers to line 22. The drawing fig. 6 is, in the original, over line 37 and fig. 7 over line 54.]

Which of these two cubes will shrink the more uniformly: the cube *A* resting on the pavement, or the cube *b* suspended in the air, when both cubes are equal in weight and bulk, and of clay mixed with equal quantities of water?

The cube placed on the pavement diminishes more in height than in breadth, which the cube above, hanging in the air, cannot do. Thus it is proved. The cube shown above is better shown here below.

The final result of the two cylinders of damp clay that is *a* and *b* will be the pyramidal figures below *c* and *d*. This is proved thus: The cylinder *a* resting on block of stone being made of clay mixed with a great deal of water will sink by its weight, which presses on its base, and in proportion as it settles and spreads all the parts will be somewhat nearer to the base because that is charged with the whole weight.

III.

ON THE NATURE OF THE ARCH.

779.

WHAT IS AN ARCH?

The arch is nothing else than a force originated by two weaknesses, for the arch in buildings is composed of two segments of a circle, each of which being very weak in itself tends to fall; but as each opposes this tendency in the other, the two weaknesses combine to form one strength.

OF THE KIND OF PRESSURE IN ARCHES.

As the arch is a composite force it remains in equilibrium because the thrust is equal from both sides; and if one of the segments weighs more than the other the stability is lost, because the greater pressure will outweigh the lesser.

OF DISTRIBUTING THE PRESSURE ABOVE AN ARCH.

Next to giving the segments of the circle equal weight it is necessary to load them equally, or you will fall into the same defect as before.

WHERE AN ARCH BREAKS.

An arch breaks at the part which lies below half way from the centre.

SECOND RUPTURE OF THE ARCH.

If the excess of weight be placed in the middle of the arch at the point *a*, that weight tends to fall towards *b*, and the arch breaks at $\frac{2}{3}$ of its height at *c e*; and *g e* is as many times stronger than *e a*, as *m o* goes into *m n*.

ON ANOTHER CAUSE OF RUIN.

The arch will likewise give way under a transversal thrust, for when the charge is not thrown directly on the foot of the arch, the arch lasts but a short time.

780.

ON THE STRENGTH OF THE ARCH.

The way to give stability to the arch is to fill the spandrils with good masonry up to the level of its summit.

ON THE LOADING OF ROUND ARCHES.

ON THE PROPER MANNER OF LOADING THE POINTED ARCH.

ON THE EVIL EFFECTS OF LOADING THE POINTED ARCH DIRECTLY ABOVE ITS CROWN.

ON THE DAMAGE DONE TO THE POINTED ARCH BY THROWING THE PRESSURE ON THE FLANKS.

An arch of small curve is safe in itself, but if it be heavily charged, it is necessary to strengthen the flanks well. An arch of a very large curve is weak in itself, and stronger if it be charged, and will do little harm to its abutments, and its places of giving way are *o p*.

[Footnote: Inside the large figure on the right is the note: *Da pesare la forza dell' arco.*]

781.

ON THE REMEDY FOR EARTHQUAKES.

The arch which throws its pressure perpendicularly on the abutments will fulfil its function whatever be its direction, upside down, sideways or upright.

The arch will not break if the chord of the outer arch does not touch the inner arch. This is manifest by experience, because whenever the chord *a o n* of the outer arch *n r a* approaches the inner arch *x b y* the arch will be weak, and it will

be weaker in proportion as the inner arch passes beyond that chord. When an arch is loaded only on one side the thrust will press on the top of the other side and be transmitted to the spring of the arch on that side; and it will break at a point half way between its two extremes, where it is farthest from the chord.

782.

A continuous body which has been forcibly bent into an arch, thrusts in the direction of the straight line, which it tends to recover.

783.

In an arch judiciously weighted the thrust is oblique, so that the triangle $c n b$ has no weight upon it.

784.

I here ask what weight will be needed to counterpoise and resist the tendency of each of these arches to give way?

[Footnote: The two lower sketches are taken from the MS. S. K. M. III, 10a; they have there no explanatory text.]

785.

ON THE STRENGTH OF THE ARCH IN ARCHITECTURE.

The stability of the arch built by an architect resides in the tie and in the flanks.

ON THE POSITION OF THE TIE IN THE ABOVE NAMED ARCH.

The position of the tie is of the same importance at the beginning of the arch and at the top of the perpendicular pier on which it rests. This is proved by the 2nd

“of supports” which says: that part of a support has least resistance which is farthest from its solid attachment; hence, as the top of the pier is farthest from the middle of its true foundation and the same being the case at the opposite extremities of the arch which are the points farthest from the middle, which is really its [upper] attachment, we have concluded that the tie *a b* requires to be in such a position as that its opposite ends are between the four above-mentioned extremes.

The adversary says that this arch must be more than half a circle, and that then it will not need a tie, because then the ends will not thrust outwards but inwards, as is seen in the excess at *a c*, *b d*. To this it must be answered that this would be a very poor device, for three reasons. The first refers to the strength of the arch, since it is proved that the circular parallel being composed of two semicircles will only break where these semicircles cross each other, as is seen in the figure *n m*; besides this it follows that there is a wider space between the extremes of the semicircle than between the plane of the walls; the third reason is that the weight placed to counterbalance the strength of the arch diminishes in proportion as the piers of the arch are wider than the space between the piers. Fourthly in proportion as the parts at *c a b d* turn outwards, the piers are weaker to support the arch above them. The 5th is that all the material and weight of the arch which are in excess of the semicircle are useless and indeed mischievous; and here it is to be noted that the weight placed above the arch will be more likely to break the arch at *a b*, where the curve of the excess begins that is added to the semicircle, than if the pier were straight up to its junction with the semicircle [spring of the arch].

AN ARCH LOADED OVER THE CROWN WILL GIVE WAY AT THE LEFT HAND AND RIGHT HAND QUARTERS.

This is proved by the 7th of this which says: The opposite ends of the support are equally pressed upon by the weight suspended to them; hence the weight shown at *f* is felt at *b c*, that is half at each extremity; and by the third which says: in a support of equal strength [throughout] that portion will give way soonest which is farthest from its attachment; whence it follows that *d* being equally distant from *f*, *e*

If the centering of the arch does not settle as the arch settles, the mortar, as it

dries, will shrink and detach itself from the bricks between which it was laid to keep them together; and as it thus leaves them disjoined the vault will remain loosely built, and the rains will soon destroy it.

786.

ON THE STRENGTH AND NATURE OF ARCHES, AND WHERE THEY ARE STRONG OR WEAK; AND THE SAME AS TO COLUMNS.

That part of the arch which is nearer to the horizontal offers least resistance to the weight placed on it.

When the triangle $a z n$, by settling, drives backwards the $2/3$ of each $1/2$ circle that is $a s$ and in the same way $z m$, the reason is that a is perpendicularly over b and so likewise z is above f .

Either half of an arch, if overweighted, will break at $2/3$ of its height, the point which corresponds to the perpendicular line above the middle of its bases, as is seen at $a b$; and this happens because the weight tends to fall past the point r . — And if, against its nature it should tend to fall towards the point s the arch $n s$ would break precisely in its middle. If the arch $n s$ were of a single piece of timber, if the weight placed at n should tend to fall in the line $n m$, the arch would break in the middle of the arch $e m$, otherwise it will break at one third from the top at the point a because from a to n the arch is nearer to the horizontal than from a to o and from o to s , in proportion as $p t$ is greater than $t n$, $a o$ will be stronger than $a n$ and likewise in proportion as $s o$ is stronger than $o a$, $r p$ will be greater than $p t$.

The arch which is doubled to four times of its thickness will bear four times the weight that the single arch could carry, and more in proportion as the diameter of its thickness goes a smaller number of times into its length. That is to say that if the thickness of the single arch goes ten times into its length, the thickness of the doubled arch will go five times into its length. Hence as the thickness of the double arch goes only half as many times into its length as that of the single arch does, it is reasonable that it should carry half as much more weight as it would have to carry if it were in direct proportion to the single arch.

Hence as this double arch has 4 times the thickness of the single arch, it would seem that it ought to bear 4 times the weight; but by the above rule it is shown that it will bear exactly 8 times as much.

THAT PIER, WHICH is CHARGED MOST UNEQUALLY, WILL SOONEST GIVE WAY.

The column *c b*, being charged with an equal weight, [on each side] will be most durable, and the other two outward columns require on the part outside of their centre as much pressure as there is inside of their centre, that is, from the centre of the column, towards the middle of the arch.

Arches which depend on chains for their support will not be very durable.

THAT ARCH WILL BE OF LONGER DURATION WHICH HAS A GOOD ABUTMENT OPPOSED TO ITS THRUST.

The arch itself tends to fall. If the arch be 30 braccia and the interval between the walls which carry it be 20, we know that 30 cannot pass through the 20 unless 20 becomes likewise 30. Hence the arch being crushed by the excess of weight, and the walls offering insufficient resistance, part, and afford room between them, for the fall of the arch.

But if you do not wish to strengthen the arch with an iron tie you must give it such abutments as can resist the thrust; and you can do this thus: fill up the spandrels *m n* with stones, and direct the lines of the joints between them to the centre of the circle of the arch, and the reason why this makes the arch durable is this. We know very well that if the arch is loaded with an excess of weight above its quarter as *a b*, the wall *f g* will be thrust outwards because the arch would yield in that direction; if the other quarter *b c* were loaded, the wall *f g* would be thrust inwards, if it were not for the line of stones *x y* which resists this.

787.

PLAN.

Here it is shown how the arches made in the side of the octagon thrust the piers of the angles outwards, as is shown by the line *h c* and by the line *t d* which thrust out the pier *m*; that is they tend to force it away from the centre of such an octagon.

788.

An Experiment to show that a weight placed on an arch does not discharge itself entirely on its columns; on the contrary the greater the weight placed on the arches, the less the arch transmits the weight to the columns. The experiment is the following. Let a man be placed on a steel yard in the middle of the shaft of a well, then let him spread out his hands and feet between the walls of the well, and you will see him weigh much less on the steel yard; give him a weight on the shoulders, you will see by experiment, that the greater the weight you give him the greater effort he will make in spreading his arms and legs, and in pressing against the wall and the less weight will be thrown on the steel yard.

IV.

ON FOUNDATIONS, THE NATURE OF THE GROUND AND SUPPORTS.

789.

The first and most important thing is stability.

As to the foundations of the component parts of temples and other public buildings, the depths of the foundations must bear the same proportions to each other as the weight of material which is to be placed upon them.

Every part of the depth of earth in a given space is composed of layers, and each layer is composed of heavier or lighter materials, the lowest being the heaviest. And this can be proved, because these layers have been formed by the sediment from water carried down to the sea, by the current of rivers which flow into it. The heaviest part of this sediment was that which was first thrown down, and so on by degrees; and this is the action of water when it becomes stagnant, having first brought down the mud whence it first flowed. And such layers of

soil are seen in the banks of rivers, where their constant flow has cut through them and divided one slope from the other to a great depth; where in gravelly strata the waters have run off, the materials have, in consequence, dried and been converted into hard stone, and this happened most in what was the finest mud; whence we conclude that every portion of the surface of the earth was once at the centre of the earth, and viceversa &c.

790.

The heaviest part of the foundations of buildings settles most, and leaves the lighter part above it separated from it.

And the soil which is most pressed, if it be porous yields most.

You should always make the foundations project equally beyond the weight of the walls and piers, as shown at *m a b*. If you do as many do, that is to say if you make a foundation of equal width from the bottom up to the surface of the ground, and charge it above with unequal weights, as shown at *b e* and at *e o*, at the part of the foundation at *b e*, the pier of the angle will weigh most and thrust its foundation downwards, which the wall at *e o* will not do; since it does not cover the whole of its foundation, and therefore thrusts less heavily and settles less. Hence, the pier *b e* in settling cracks and parts from the wall *e o*. This may be seen in most buildings which are cracked round the piers.

791.

The window *a* is well placed under the window *c*, and the window *b* is badly placed under the pier *d*, because this latter is without support and foundation; mind therefore never to make a break under the piers between the windows.

792.

OF THE SUPPORTS.

A pillar of which the thickness is increased will gain more than its due strength, in direct proportion to what it loses in relative height.

EXAMPLE.

If a pillar should be nine times as high as it is broad — that is to say, if it is one braccio thick, according to rule it should be nine braccia high — then, if you place 100 such pillars together in a mass this will be ten braccia broad and 9 high; and if the first pillar could carry 10000 pounds the second being only about as high as it is wide, and thus lacking 8 parts of its proper length, it, that is to say, each pillar thus united, will bear eight times more than when disconnected; that is to say, that if at first it would carry ten thousand pounds, it would now carry 90 thousand.

V.

ON THE RESISTANCE OF BEAMS.

That angle will offer the greatest resistance which is most acute, and the most obtuse will be the weakest.

[Footnote: The three smaller sketches accompany the text in the original, but the larger one is not directly connected with it. It is to be found on fol. 89a of the same Manuscript and there we read in a note, written underneath, *coverchio della perdicha del castello* (roof of the flagstaff of the castle), — Compare also Pl. XCIII, No. 1.]

794.

If the beams and the weight *o* are 100 pounds, how much weight will be wanted at *ae* to resist such a weight, that it may not fall down?

795.

ON THE LENGTH OF BEAMS.

That beam which is more than 20 times as long as its greatest thickness will be of brief duration and will break in half; and remember, that the part built into the wall should be steeped in hot pitch and filleted with oak boards likewise so steeped. Each beam must pass through its walls and be secured beyond the walls with sufficient chaining, because in consequence of earthquakes the beams are often seen to come out of the walls and bring down the walls and floors; whilst if they are chained they will hold the walls strongly together and the walls will hold the floors. Again I remind you never to put plaster over timber. Since by expansion and shrinking of the timber produced by damp and dryness such floors often crack, and once cracked their divisions gradually produce dust and an ugly effect. Again remember not to lay a floor on beams supported on arches; for, in time the floor which is made on beams settles somewhat in the middle while that part of the floor which rests on the arches remains in its place; hence, floors laid over two kinds of supports look, in time, as if they were made in hills [Footnote: 19 M. RAVAISSON, in his edition of MS. A gives a very different rendering of this passage translating it thus: *Les planchers qui sont soutenus par deux differentes natures de supports paraissent avec le temps faits en voute a cholli.*]

Remarks on the style of Leonardo's architecture.

A few remarks may here be added on the style of Leonardo's architectural studies. However incomplete, however small in scale, they allow us to establish a certain number of facts and probabilities, well worthy of consideration.

When Leonardo began his studies the great name of Brunellesco was still the inspiration of all Florence, and we cannot doubt that Leonardo was open to it, since we find among his sketches the plan of the church of Santo Spirito [Footnote 1: See Pl. XCIV, No. 2. Then only in course of erection after the designs of Brunellesco, though he was already dead; finished in 1481.] and a lateral view of San Lorenzo (Pl. XCIV No. 1), a plan almost identical with the chapel Degli Angeli, only begun by him (Pl. XCIV, No. 3) while among Leonardo's designs for domes several clearly betray the influence of Brunellesco's Cupola and the lantern of Santa Maria del Fiore [Footnote 2: A small sketch of the tower of the Palazzo della Signoria (MS. C.A. 309) proves that he also studied mediaeval monuments.]

The beginning of the second period of modern Italian architecture falls during the first twenty years of Leonardo's life. However the new impetus given by Leon Battista Alberti either was not generally understood by his contemporaries, or those who appreciated it, had no opportunity of showing that they did so. It was only when taken up by Bramante and developed by him to the highest rank

of modern architecture that this new influence was generally felt. Now the peculiar feature of Leonardo's sketches is that, like the works of Bramante, they appear to be the development and continuation of Alberti's.

But a question here occurs which is difficult to answer. Did Leonardo, till he quitted Florence, follow the direction given by the dominant school of Brunellesco, which would then have given rise to his "First manner", or had he, even before he left Florence, felt Alberti's influence — either through his works (Palazzo Rucellai, and the front of Santa Maria Novella) or through personal intercourse? Or was it not till he went to Milan that Alberti's work began to impress him through Bramante, who probably had known Alberti at Mantua about 1470 and who not only carried out Alberti's views and ideas, but, by his designs for St. Peter's at Rome, proved himself the greatest of modern architects. When Leonardo went to Milan Bramante had already been living there for many years. One of his earliest works in Milan was the church of Santa Maria presso San Satiro, Via del Falcone[Footnote 1: Evidence of this I intend to give later on in a Life of Bramante, which I have in preparation.].

Now we find among Leonardos studies of Cupolas on Plates LXXXIV and LXXXV and in Pl. LXXX several sketches which seem to me to have been suggested by Bramante's dome of this church.

The MSS. B and Ash. II contain the plans of S. Sepolcro, the pavilion in the garden of the duke of Milan, and two churches, evidently inspired by the church of San Lorenzo at Milan.

MS. B. contains besides two notes relating to Pavia, one of them a design for the sacristy of the Cathedral at Pavia, which cannot be supposed to be dated later than 1492, and it has probably some relation to Leonardo's call to Pavia June 21, 1490[Footnote 2: The sketch of the plan of Brunellesco's church of Santo Spirito at Florence, which occurs in the same Manuscript, may have been done from memory.]. These and other considerations justify us in concluding, that Leonardo made his studies of cupolas at Milan, probably between the years 1487 and 1492 in anticipation of the erection of one of the grandest churches of Italy, the Cathedral of Pavia. This may explain the decidedly Lombardo-Bramantesque tendency in the style of these studies, among which only a few remind us of the forms of the cupolas of S. Maria del Fiore and of the Baptistry of Florence. Thus, although when compared with Bramante's work, several of these sketches plainly reveal that master's influence, we find, among the sketches of domes, some, which show already Bramante's classic style, of which the Tempietto of San Pietro in Montorio, his first building executed at Rome, is the foremost example[Footnote 3: It may be mentioned here, that in 1494 Bramante made a similar design for the lantern of the Cupola of the Church of Santa Maria delle

Grazie.].

On Plate LXXXIV is a sketch of the plan of a similar circular building; and the Mausoleum on Pl. XCVIII, no less than one of the pedestals for the statue of Francesco Sforza (Pl. LXV), is of the same type.

The drawings Pl. LXXXIV No. 2, Pl. LXXXVI No. 1 and 2 and the ground flour ("flour" sic but should be "floor" ?) of the building in the drawing Pl. XCI No. 2, with the interesting decoration by gigantic statues in large niches, are also, I believe, more in the style Bramante adopted at Rome, than in the Lombard style. Are we to conclude from this that Leonardo on his part influenced Bramante in the sense of simplifying his style and rendering it more congenial to antique art? The answer to this important question seems at first difficult to give, for we are here in presence of Bramante, the greatest of modern architects, and with Leonardo, the man comparable with no other. We have no knowledge of any buildings erected by Leonardo, and unless we admit personal intercourse — which seems probable, but of which there is no proof — , it would be difficult to understand how Leonardo could have affected Bramante's style. The converse is more easily to be admitted, since Bramante, as we have proved elsewhere, drew and built simultaneously in different manners, and though in Lombardy there is no building by him in his classic style, the use of brick for building, in that part of Italy, may easily account for it.

Bramante's name is incidentally mentioned in Leonardo's manuscripts in two passages (Nos. 1414 and 1448). On each occasion it is only a slight passing allusion, and the nature of the context gives us no due information as to any close connection between the two artists.

It might be supposed, on the ground of Leonardo's relations with the East given in sections XVII and XXI of this volume, that some evidence of oriental influence might be detected in his architectural drawings. I do not however think that any such traces can be pointed out with certainty unless perhaps the drawing for a Mausoleum, Pl. XC VIII.

Among several studies for the construction of cupolas above a Greek cross there are some in which the forms are decidedly monotonous. These, it is clear, were not designed as models of taste; they must be regarded as the results of certain investigations into the laws of proportion, harmony and contrast.

The designs for churches, on the plan of a Latin cross are evidently intended to depart as little as possible from the form of a Greek cross; and they also show a preference for a nave surrounded with outer porticos.

The architectural forms preferred by Leonardo are pilasters coupled (Pl. LXXXII No. 1; or grouped (Pl. LXXX No. 5 and XCIV No. 4), often combined with niches. We often meet with orders superposed, one in each story, or two

small orders on one story, in combination with one great order (Pl. XCVI No. 2).

The drum (tamburo) of these cupolas is generally octagonal, as in the cathedral of Florence, and with similar round windows in its sides. In Pl. LXXXVII No. 2 it is circular like the model actually carried out by Michael Angelo at St. Peter's.

The cupola itself is either hidden under a pyramidal roof, as in the Baptistery of Florence, San Lorenzo of Milan and most of the Lombard churches (Pl. XCI No. 1 and Pl. XCII No. 1); but it more generally suggests the curve of Sta Maria del Fiore (Pl. LXXXVIII No. 5; Pl. XC No. 2; Pl. LXXXIX, M; Pl. XC No. 4, Pl. XCVI No. 2). In other cases (Pl. LXXX No. 4; Pl. LXXXIX; Pl. XC No. 2) it shows the sides of the octagon crowned by semicircular pediments, as in Brunellesco's lantern of the Cathedral and in the model for the Cathedral of Pavia.

Finally, in some sketches the cupola is either semicircular, or as in Pl. LXXXVII No. 2, shows the beautiful line, adopted sixty years later by Michael Angelo for the existing dome of St. Peter's.

It is worth noticing that for all these domes Leonardo is not satisfied to decorate the exterior merely with ascending ribs or mouldings, but employs also a system of horizontal parallels to complete the architectural system. Not the least interesting are the designs for the tiburio (cupola) of the Milan Cathedral. They show some of the forms, just mentioned, adapted to the peculiar gothic style of that monument.

The few examples of interiors of churches recall the style employed in Lombardy by Bramante, for instance in S. Maria di Canepanuova at Pavia, or by Dolcebuono in the Monastero Maggiore at Milan (see Pl. CI No. 1 [C. A. 181b; 546b]; Pl. LXXXIV No. 10).

The few indications concerning palaces seem to prove that Leonardo followed Alberti's example of decorating the walls with pilasters and a flat rustica, either in stone or by graffiti (Pl. CII No. 1 and Pl. LXXXV No. 14).

By pointing out the analogies between Leonardo's architecture and that of other masters we in no way pretend to depreciate his individual and original inventive power. These are at all events beyond dispute. The project for the Mausoleum (Pl. XCVIII) would alone suffice to rank him among the greatest architects who ever lived. The peculiar shape of the tower (Pl. LXXX), of the churches for preaching (Pl. XCVII No. 1 and pages 56 and 57, Fig. 1-4), his curious plan for a city with high and low level streets (Pl. LXXXVII and LXXXVIII No. 2 and No. 3), his Loggia with fountains (Pl. LXXXII No. 4) reveal an originality, a power and facility of invention for almost any given problem, which are quite wonderful.

In addition to all these qualities he probably stood alone in his day in one department of architectural study, — his investigations, namely, as to the resistance of vaults, foundations, walls and arches.

As an application of these studies the plan of a semicircular vault (Pl. CIII No. 2) may be mentioned here, disposed so as to produce no thrust on the columns on which it rests: volta i botte e non ispignie ifori le colone. Above the geometrical patterns on the same sheet, close to a circle inscribed in a square is the note: la raggio d'una volta cioe il terzo del diamitro della sua ... del tedesco in domo.

There are few data by which to judge of Leonardo's style in the treatment of detail. On Pl. LXXXV No. 10 and Pl. CIII No. 3, we find some details of pillars; on Pl. CI No. 3 slender pillars designed for a fountain and on Pl. CIII No. 1 MS. B, is a pen and ink drawing of a vase which also seems intended for a fountain. Three handles seem to have been intended to connect the upper parts with the base. There can be no doubt that Leonardo, like Bramante, but unlike Michael Angelo, brought infinite delicacy of motive and execution to bear on the details of his work.

XIV. ANATOMY, ZOOLOGY AND PHYSIOLOGY.

Leonardo's eminent place in the history of medicine, as a pioneer in the sciences of Anatomy and Physiology, will never be appreciated till it is possible to publish the mass of manuscripts in which he largely treated of these two branches of learning. In the present work I must necessarily limit myself to giving the reader a general view of these labours, by publishing his introductory notes to the various books on anatomical subjects. I have added some extracts, and such observations as are scattered incidentally through these treatises, as serving to throw a light on Leonardo's scientific attitude, besides having an interest for a wider circle than that of specialists only.

VASARI expressly mentions Leonardo's anatomical studies, having had occasion to examine the manuscript books which refer to them. According to him Leonardo studied Anatomy in the companionship of Marc Antonio della Torre "aiutato e scambievolmente aiutando." — This learned Anatomist taught the science in the universities first of Padua and then of Pavia, and at Pavia he and Leonardo may have worked and studied together. We have no clue to any exact dates, but in the year 1506 Marc Antonio della Torre seems to have not yet left Padua. He was scarcely thirty years old when he died in 1512, and his writings on anatomy have not only never been published, but no manuscript copy of them is known to exist.

This is not the place to enlarge on the connection between Leonardo and Marc Antonio della Torre. I may however observe that I have not been able to discover in Leonardo's manuscripts on anatomy any mention of his younger contemporary. The few quotations which occur from writers on medicine — either of antiquity or of the middle ages are printed in Section XXII. Here and there in the manuscripts mention is made of an anonymous "adversary" (avversario) whose views are opposed and refuted by Leonardo, but there is no ground for supposing that Marc Antonio della Torre should have been this "adversary".

Only a very small selection from the mass of anatomical drawings left by Leonardo have been published here in facsimile, but to form any adequate idea of their scientific merit they should be compared with the coarse and inadequate figures given in the published books of the early part of the XVI. century.

William Hunter, the great surgeon — a competent judge — who had an

opportunity in the time of George III. of seeing the originals in the King's Library, has thus recorded his opinion: "I expected to see little more than such designs in Anatomy as might be useful to a painter in his own profession. But I saw, and indeed with astonishment, that Leonardo had been a general and deep student. When I consider what pains he has taken upon every part of the body, the superiority of his universal genius, his particular excellence in mechanics and hydraulics, and the attention with which such a man would examine and see objects which he has to draw, I am fully persuaded that Leonardo was the best Anatomist, at that time, in the world ... Leonardo was certainly the first man, we know of, who introduced the practice of making anatomical drawings" (Two introductory letters. London 1784, pages 37 and 39).

The illustrious German Naturalist Johan Friedrich Blumenbach esteemed them no less highly; he was one of the privileged few who, after Hunter, had the chance of seeing these Manuscripts. He writes: *Der Scharfblick dieses grossen Forschers und Darstellers der Natur hat schon auf Dinge geachtet, die noch Jahrhunderte nachher unbemerkt geblieben sind*" (see Blumenbach's *medizinische Bibliothek*, Vol. 3, St. 4, 1795. page 728).

These opinions were founded on the drawings alone. Up to the present day hardly anything has been made known of the text, and, for the reasons I have given, it is my intention to reproduce here no more than a selection of extracts which I have made from the originals at Windsor Castle and elsewhere. In the Bibliography of the Manuscripts, at the end of this volume a short review is given of the valuable contents of these Anatomical note books which are at present almost all in the possession of her Majesty the Queen of England. It is, I believe, possible to assign the date with approximate accuracy to almost all the fragments, and I am thus led to conclude that the greater part of Leonardo's anatomical investigations were carried out after the death of della Torre.

Merely in reading the introductory notes to his various books on Anatomy which are here printed it is impossible to resist the impression that the Master's anatomical studies bear to a very great extent the stamp of originality and independent thought.

I.

ANATOMY.

A general introduction

I wish to work miracles; — it may be that I shall possess less than other men of more peaceful lives, or than those who want to grow rich in a day. I may live for a long time in great poverty, as always happens, and to all eternity will happen, to alchemists, the would-be creators of gold and silver, and to engineers who would have dead water stir itself into life and perpetual motion, and to those supreme fools, the necromancer and the enchanter.

[Footnote 23: The following seems to be directed against students of painting and young artists rather than against medical men and anatomists.]

And you, who say that it would be better to watch an anatomist at work than to see these drawings, you would be right, if it were possible to observe all the things which are demonstrated in such drawings in a single figure, in which you, with all your cleverness, will not see nor obtain knowledge of more than some few veins, to obtain a true and perfect knowledge of which I have dissected more than ten human bodies, destroying all the other members, and removing the very minutest particles of the flesh by which these veins are surrounded, without causing them to bleed, excepting the insensible bleeding of the capillary veins; and as one single body would not last so long, since it was necessary to proceed with several bodies by degrees, until I came to an end and had a complete knowledge; this I repeated twice, to learn the differences .

[Footnote: Lines 1-59 and 60-89 are written in two parallel columns. When we here find Leonardo putting himself in the same category as the Alchemists and Necromancers, whom he elsewhere mocks at so bitterly, it is evidently meant ironically. In the same way Leonardo, in the introduction to the Books on Perspective sets himself with transparent satire on a level with other writers on the subject.]

And if you should have a love for such things you might be prevented by loathing, and if that did not prevent you, you might be deterred by the fear of living in the night hours in the company of those corpses, quartered and flayed and horrible to see. And if this did not prevent you, perhaps you might not be able to draw so well as is necessary for such a demonstration; or, if you had the skill in drawing, it might not be combined with knowledge of perspective; and if it were so, you might not understand the methods of geometrical demonstration and the method of the calculation of forces and of the strength of the muscles; patience also may be wanting, so that you lack perseverance. As to whether all these things were found in me or not [Footnote 84: Leonardo frequently, and

perhaps habitually, wrote in note books of a very small size and only moderately thick; in most of those which have been preserved undivided, each contains less than fifty leaves. Thus a considerable number of such volumes must have gone to make up a volume of the bulk of the '*Codex Atlanticus*' which now contains nearly 1200 detached leaves. In the passage under consideration, which was evidently written at a late period of his life, Leonardo speaks of his Manuscript note-books as numbering 120; but we should hardly be justified in concluding from this passage that the greater part of his Manuscripts were now missing (see *Prolegomena*, Vol. I, pp. 5-7).], the hundred and twenty books composed by me will give verdict Yes or No. In these I have been hindered neither by avarice nor negligence, but simply by want of time. Farewell .

Plans and suggestions for the arrangement of materials (797-802).

797.

OF THE ORDER OF THE BOOK.

This work must begin with the conception of man, and describe the nature of the womb and how the foetus lives in it, up to what stage it resides there, and in what way it quickens into life and feeds. Also its growth and what interval there is between one stage of growth and another. What it is that forces it out from the body of the mother, and for what reasons it sometimes comes out of the mother's womb before the due time.

Then I will describe which are the members, which, after the boy is born, grow more than the others, and determine the proportions of a boy of one year.

Then describe the fully grown man and woman, with their proportions, and the nature of their complexions, colour, and physiognomy.

Then how they are composed of veins, tendons, muscles and bones. This I shall do at the end of the book. Then, in four drawings, represent four universal conditions of men. That is, Mirth, with various acts of laughter, and describe the cause of laughter. Weeping in various aspects with its causes. Contention, with various acts of killing; flight, fear, ferocity, boldness, murder and every thing pertaining to such cases. Then represent Labour, with pulling, thrusting, carrying, stopping, supporting and such like things.

Further I would describe attitudes and movements. Then perspective, concerning the functions and effects of the eye; and of hearing — here I will

speak of music — , and treat of the other senses.

And then describe the nature of the senses.

This mechanism of man we will demonstrate in ... figures; of which the three first will show the ramification of the bones; that is: first one to show their height and position and shape: the second will be seen in profile and will show the depth of the whole and of the parts, and their position. The third figure will be a demonstration of the bones of the backparts. Then I will make three other figures from the same point of view, with the bones sawn across, in which will be shown their thickness and hollowness. Three other figures of the bones complete, and of the nerves which rise from the nape of the neck, and in what limbs they ramify. And three others of the bones and veins, and where they ramify. Then three figures with the muscles and three with the skin, and their proper proportions; and three of woman, to illustrate the womb and the menstrual veins which go to the breasts.

[Footnote: The meaning of the word *nervo* varies in different passages, being sometimes used for *muscolo* (muscle).]

798.

THE ORDER OF THE BOOK.

This depicting of mine of the human body will be as clear to you as if you had the natural man before you; and the reason is that if you wish thoroughly to know the parts of man, anatomically, you — or your eye — require to see it from different aspects, considering it from below and from above and from its sides, turning it about and seeking the origin of each member; and in this way the natural anatomy is sufficient for your comprehension. But you must understand that this amount of knowledge will not continue to satisfy you; seeing the very great confusion that must result from the combination of tissues, with veins, arteries, nerves, sinews, muscles, bones, and blood which, of itself, tinges every part the same colour. And the veins, which discharge this blood, are not discerned by reason of their smallness. Moreover integrity of the tissues, in the process of the investigating the parts within them, is inevitably destroyed, and their transparent substance being tinged with blood does not allow you to recognise the parts covered by them, from the similarity of their blood-stained hue; and you cannot know everything of the one without confusing and

destroying the other. Hence, some further anatomy drawings become necessary. Of which you want three to give full knowledge of the veins and arteries, everything else being destroyed with the greatest care. And three others to display the tissues; and three for the sinews and muscles and ligaments; and three for the bones and cartilages; and three for the anatomy of the bones, which have to be sawn to show which are hollow and which are not, which have marrow and which are spongy, and which are thick from the outside inwards, and which are thin. And some are extremely thin in some parts and thick in others, and in some parts hollow or filled up with bone, or full of marrow, or spongy. And all these conditions are sometimes found in one and the same bone, and in some bones none of them. And three you must have for the woman, in which there is much that is mysterious by reason of the womb and the foetus. Therefore by my drawings every part will be known to you, and all by means of demonstrations from three different points of view of each part; for when you have seen a limb from the front, with any muscles, sinews, or veins which take their rise from the opposite side, the same limb will be shown to you in a side view or from behind, exactly as if you had that same limb in your hand and were turning it from side to side until you had acquired a full comprehension of all you wished to know. In the same way there will be put before you three or four demonstrations of each limb, from various points of view, so that you will be left with a true and complete knowledge of all you wish to learn of the human figure[Footnote 35: Compare Pl. CVII. The original drawing at Windsor is 28 1/2 X 19 1/2 centimetres. The upper figures are slightly washed with Indian ink. On the back of this drawing is the text No. 1140.].

Thus, in twelve entire figures, you will have set before you the cosmography of this lesser world on the same plan as, before me, was adopted by Ptolemy in his cosmography; and so I will afterwards divide them into limbs as he divided the whole world into provinces; then I will speak of the function of each part in every direction, putting before your eyes a description of the whole form and substance of man, as regards his movements from place to place, by means of his different parts. And thus, if it please our great Author, I may demonstrate the nature of men, and their customs in the way I describe his figure.

And remember that the anatomy of the nerves will not give the position of their ramifications, nor show you which muscles they branch into, by means of bodies dissected in running water or in lime water; though indeed their origin and starting point may be seen without such water as well as with it. But their ramifications, when under running water, cling and unite — just like flat or hemp carded for spinning — all into a skein, in a way which makes it impossible to trace in which muscles or by what ramification the nerves are distributed

among those muscles.

799.

THE ARRANGEMENT OF ANATOMY

First draw the bones, let us say, of the arm, and put in the motor muscle from the shoulder to the elbow with all its lines. Then proceed in the same way from the elbow to the wrist. Then from the wrist to the hand and from the hand to the fingers.

And in the arm you will put the motors of the fingers which open, and these you will show separately in their demonstration. In the second demonstration you will clothe these muscles with the secondary motors of the fingers and so proceed by degrees to avoid confusion. But first lay on the bones those muscles which lie close to the said bones, without confusion of other muscles; and with these you may put the nerves and veins which supply their nourishment, after having first drawn the tree of veins and nerves over the simple bones.

800.

Begin the anatomy at the head and finish at the sole of the foot.

801.

3 men complete, 3 with bones and nerves, 3 with the bones only. Here we have 12 demonstrations of entire figures.

802.

When you have finished building up the man, you will make the statue with all its superficial measurements.

[Footnote: *Cresciere l'omo*. The meaning of this expression appears to be different here and in the passage C.A. 157a, 468a (see No. 526, Note 1. 2). Here it can hardly mean anything else than modelling, since the sculptor forms the figure by degrees, by adding wet clay and the figure consequently increases or

grows. *Tu farai la statua* would then mean, you must work out the figure in marble. If this interpretation is the correct one, this passage would have no right to find a place in the series on anatomical studies. I may say that it was originally inserted in this connection under the impression that *di crescere* should be read *descrivere*.]

Plans for the representation of muscles by drawings (803-809).

803.

You must show all the motions of the bones with their joints to follow the demonstration of the first three figures of the bones, and this should be done in the first book.

804.

Remember that to be certain of the point of origin of any muscle, you must pull the sinew from which the muscle springs in such a way as to see that muscle move, and where it is attached to the ligaments of the bones.

NOTE.

You will never get any thing but confusion in demonstrating the muscles and their positions, origin, and termination, unless you first make a demonstration of thin muscles after the manner of linen threads; and thus you can represent them, one over another as nature has placed them; and thus, too, you can name them according to the limb they serve; for instance the motor of the point of the great toe, of its middle bone, of its first bone, &c. And when you have the knowledge you will draw, by the side of this, the true form and size and position of each muscle. But remember to give the threads which explain the situation of the muscles in the position which corresponds to the central line of each muscle; and so these threads will demonstrate the form of the leg and their distance in a plain and clear manner.

I have removed the skin from a man who was so shrunk by illness that the muscles were worn down and remained in a state like thin membrane, in such a way that the sinews instead of merging in muscles ended in wide membrane; and where the bones were covered by the skin they had very little over their natural

size.

[Footnote: The photograph No. 41 of Grosvenor Gallery Publications: a drawing of the muscles of the foot, includes a complete facsimile of the text of this passage.]

805.

Which nerve causes the motion of the eye so that the motion of one eye moves the other?

Of frowning the brows, of raising the brows, of lowering the brows, — of closing the eyes, of opening the eyes, — of raising the nostrils, of opening the lips, with the teeth shut, of pouting with the lips, of smiling, of astonishment. —

Describe the beginning of man when it is caused in the womb and why an eight months child does not live. What sneezing is. What yawning is. Falling sickness, spasms, paralysis, shivering with cold, sweating, fatigue, hunger, sleepiness, thirst, lust.

Of the nerve which is the cause of movement from the shoulder to the elbow, of the movement from the elbow to the hand, from the joint of the hand to the springing of the fingers. From the springing of the fingers to the middle joints, and from the middle joints to the last.

Of the nerve which causes the movement of the thigh, and from the knee to the foot, and from the joint of the foot to the toes, and then to the middle of the toes and of the rotary motion of the leg.

806.

ANATOMY.

Which nerves or sinews of the hand are those which close and part the fingers and toes latteraly?

807.

Remove by degrees all the parts of the front of a man in making your

dissection, till you come to the bones. Description of the parts of the bust and of their motions.

808.

Give the anatomy of the leg up to the hip, in all views and in every action and in every state; veins, arteries, nerves, sinews and muscles, skin and bones; then the bones in sections to show the thickness of the bones.

[Footnote: A straightened leg in profile is sketched by the side of this text.]

On corpulency and leanness (809-811).

809.

Make the rule and give the measurement of each muscle, and give the reasons of all their functions, and in which way they work and what makes them work &c.

First draw the spine of the back; then clothe it by degrees, one after the other, with each of its muscles and put in the nerves and arteries and veins to each muscle by itself; and besides these note the vertebrae to which they are attached; which of the intestines come in contact with them; and which bones and other organs &c.

The most prominent parts of lean people are most prominent in the muscular, and equally so in fat persons. But concerning the difference in the forms of the muscles in fat persons as compared with muscular persons, it shall be described below.

[Footnote: The two drawings given on Pl. CVIII no. 1 come between lines 3 and 4. A good and very early copy of this drawing without the written text exists in the collection of drawings belonging to Christ's College Oxford, where it is attributed to Leonardo.]

810.

Describe which muscles disappear in growing fat, and which become visible in growing lean.

And observe that that part which on the surface of a fat person is most concave, when he grows lean becomes more prominent.

Where the muscles separate one from another you must give profiles and where they coalesce ...

811.

OF THE HUMAN FIGURE.

Which is the part in man, which, as he grows fatter, never gains flesh?

Or what part which as a man grows lean never falls away with a too perceptible diminution? And among the parts which grow fat which is that which grows fattest?

Among those which grow lean which is that which grows leanest?

In very strong men which are the muscles which are thickest and most prominent?

In your anatomy you must represent all the stages of the limbs from man's creation to his death, and then till the death of the bone; and which part of him is first decayed and which is preserved the longest.

And in the same way of extreme leanness and extreme fatness.

The divisions of the head (812. 813).

812.

ANATOMY.

There are eleven elementary tissues: — Cartilage, bones, nerves, veins, arteries, fascia, ligament and sinews, skin, muscle and fat.

OF THE HEAD.

The divisions of the head are 10, viz. 5 external and 5 internal, the external are the hair, skin, muscle, fascia and the skull; the internal are the dura mater, the pia mater, [which enclose] the brain. The pia mater and the dura mater come again

underneath and enclose the brain; then the rete mirabile, and the occipital bone, which supports the brain from which the nerves spring.

813.

- a.* hair
- n.* skin
- c.* muscle
- m.* fascia
- o.* skull *i.e.* bone
- b.* dura mater
- d.* pia mater
- f.* brain
- r.* pia mater, below
- t.* dura mater
- l.* rete mirablile
- s.* the occipitul bone.

[Footnote: See Pl. CVIII, No. 3.]

Physiological problems (814. 815).

814.

Of the cause of breathing, of the cause of the motion of the heart, of the cause of vomiting, of the cause of the descent of food from the stomach, of the cause of emptying the intestines.

Of the cause of the movement of the superfluous matter through the intestines.

Of the cause of swallowing, of the cause of coughing, of the cause of yawning, of the cause of sneezing, of the cause of limbs getting asleep.

Of the cause of losing sensibility in any limb.

Of the cause of tickling.

Of the cause of lust and other appetites of the body, of the cause of urine and also of all the natural excretions of the body.

[Footnote: By the side of this text stands the pen and ink drawing reproduced on Pl. CVIII, No. 4; a skull with indications of the veins in the fleshy covering.]

815.

The tears come from the heart and not from the brain.

Define all the parts, of which the body is composed, beginning with the skin with its outer cuticle which is often chapped by the influence of the sun.

II.

ZOOLOGY AND COMPARATIVE ANATOMY.

The divisions of the animal kingdom (816. 817).

816.

Man. The description of man, which includes that of such creatures as are of almost the same species, as Apes, Monkeys and the like, which are many,

The Lion and its kindred, as Panthers. [Footnote 3: *Leonza* — wild cat? “*Secondo alcuni, lo stesso che Leonessa; e secondo altri con piu certezza, lo stesso che Pantera*” FANFANI, *Vocabolario* page 858.] Wildcats (?) Tigers, Leopards, Wolves, Lynxes, Spanish cats, common cats and the like.

The Horse and its kindred, as Mule, Ass and the like, with incisor teeth above and below.

The Bull and its allies with horns and without upper incisors as the Buffalo, Stag Fallow Deer, Wild Goat, Swine, Goat, wild Goats Muskdeers, Chamois, Giraffe.

817.

Describe the various forms of the intestines of the human species, of apes and such like. Then, in what way the leonine species differ, and then the bovine, and finally birds; and arrange this description after the manner of a disquisition.

Miscellaneous notes on the study of Zoology (818-821).

818.

Procure the placenta of a calf when it is born and observe the form of the cotyledons, if their cotyledons are male or female.

819.

Describe the tongue of the woodpecker and the jaw of the crocodile.

820.

Of the flight of the 4th kind of butterflies that consume winged ants. Of the three principal positions of the wings of birds in downward flight.

[Footnote: A passing allusion is all I can here permit myself to Leonardo's elaborate researches into the flight of birds. Compare the observations on this subject in the Introduction to section XVIII and in the Bibliography of Manuscripts at the end of the work.]

821.

Of the way in which the tail of a fish acts in propelling the fish; as in the eel, snake and leech.

[Footnote: A sketch of a fish, swimming upwards is in the original, inserted above this text. — Compare No. 1114.]

Comparative study of the structure of bones and of the action of muscles (822-826).

822.

OF THE PALM OF THE HAND.

Then I will discourse of the hands of each animal to show in what they vary; as in the bear, which has the ligatures of the sinews of the toes joined above the instep.

823.

A second demonstration inserted between anatomy and [the treatise on] the

living being.

You will represent here for a comparison, the legs of a frog, which have a great resemblance to the legs of man, both in the bones and in the muscles. Then, in continuation, the hind legs of the hare, which are very muscular, with strong active muscles, because they are not encumbered with fat.

[Footnote: This text is written by the side of a drawing in black chalk of a nude male figure, but there is no connection between the sketch and the text.]

824.

Here I make a note to demonstrate the difference there is between man and the horse and in the same way with other animals. And first I will begin with the bones, and then will go on to all the muscles which spring from the bones without tendons and end in them in the same way, and then go on to those which start with a single tendon at one end.

[Footnote: See Pl. CVIII, No. 2.]

825.

Note on the bendings of joints and in what way the flesh grows upon them in their flexions or extensions; and of this most important study write a separate treatise: in the description of the movements of animals with four feet; among which is man, who likewise in his infancy crawls on all fours.

826.

OF THE WAY OF WALKING IN MAN.

The walking of man is always after the universal manner of walking in animals with 4 legs, inasmuch as just as they move their feet crosswise after the manner of a horse in trotting, so man moves his 4 limbs crosswise; that is, if he puts forward his right foot in walking he puts forward, with it, his left arm and vice versa, invariably.

III.

PHYSIOLOGY.

Comparative study of the organs of sense in men and animals.

827.

I have found that in the composition of the human body as compared with the bodies of animals the organs of sense are duller and coarser. Thus it is composed of less ingenious instruments, and of spaces less capacious for receiving the faculties of sense. I have seen in the Lion tribe that the sense of smell is connected with part of the substance of the brain which comes down the nostrils, which form a spacious receptacle for the sense of smell, which enters by a great number of cartilaginous vesicles with several passages leading up to where the brain, as before said, comes down.

The eyes in the Lion tribe have a large part of the head for their sockets and the optic nerves communicate at once with the brain; but the contrary is to be seen in man, for the sockets of the eyes are but a small part of the head, and the optic nerves are very fine and long and weak, and by the weakness of their action we see by day but badly at night, while these animals can see as well at night as by day. The proof that they can see is that they prow1 for prey at night and sleep by day, as nocturnal birds do also.

Advantages in the structure of the eye in certain animals (828-831).

828.

Every object we see will appear larger at midnight than at midday, and larger in the morning than at midday.

This happens because the pupil of the eye is much smaller at midday than at any other time.

In proportion as the eye or the pupil of the owl is larger in proportion to the animal than that of man, so much the more light can it see at night than man can; hence at midday it can see nothing if its pupil does not diminish; and, in the same way, at night things look larger to it than by day.

829.

OF THE EYES IN ANIMALS.

The eyes of all animals have their pupils adapted to dilate and diminish of their own accord in proportion to the greater or less light of the sun or other luminary. But in birds the variation is much greater; and particularly in nocturnal birds, such as horned owls, and in the eyes of one species of owl; in these the pupil dilates in such away as to occupy nearly the whole eye, or diminishes to the size of a grain of millet, and always preserves the circular form. But in the Lion tribe, as panthers, pards, ounces, tigers, lynxes, Spanish cats and other similar animals the pupil diminishes from the perfect circle to the figure of a pointed oval such as is shown in the margin. But man having a weaker sight than any other animal is less hurt by a very strong light and his pupil increases but little in dark places; but in the eyes of these nocturnal animals, the horned owl — a bird which is the largest of all nocturnal birds — the power of vision increases so much that in the faintest nocturnal light (which we call darkness) it sees with much more distinctness than we do in the splendour of noon day, at which time these birds remain hidden in dark holes; or if indeed they are compelled to come out into the open air lighted up by the sun, they contract their pupils so much that their power of sight diminishes together with the quantity of light admitted.

Study the anatomy of various eyes and see which are the muscles which open and close the said pupils of the eyes of animals.

[Footnote: Compare No. 24, lines 8 and fol.]

830.

a b n is the membrane which closes the eye from below, upwards, with an opaque film, *c n b* encloses the eye in front and behind with a transparent membrane.

It closes from below, upwards, because it [the eye] comes downwards.

When the eye of a bird closes with its two lids, the first to close is the nictitating membrane which closes from the lacrymal duct over to the outer corner of the eye; and the outer lid closes from below upwards, and these two intersecting motions begin first from the lacrymatory duct, because we have

already seen that in front and below birds are protected and use only the upper portion of the eye from fear of birds of prey which come down from above and behind; and they uncover first the membrane from the outer corner, because if the enemy comes from behind, they have the power of escaping to the front; and again the muscle called the nictitating membrane is transparent, because, if the eye had not such a screen, they could not keep it open against the wind which strikes against the eye in the rush of their rapid flight. And the pupil of the eye dilates and contracts as it sees a less or greater light, that is to say intense brilliancy.

831.

If at night your eye is placed between the light and the eye of a cat, it will see the eye look like fire.

Remarks on the organs of speech
(832. 833).

832.

*a e i o u ba be bi bo bu ca ce ci co cu da de di do du fa fe fi fo fu ga ge gi go
gu la le li lo lu ma me mi mo mu na ne ni no nu pa pe pi po pu qa qe qi qo qu ra
re ri ro ru sa se si so su ta te ti to tu*

The tongue is found to have 24 muscles which correspond to the six muscles which compose the portion of the tongue which moves in the mouth.

And when *a o u* are spoken with a clear and rapid pronunciation, it is necessary, in order to pronounce continuously, without any pause between, that the opening of the lips should close by degrees; that is, they are wide apart in saying *a*, closer in saying *o*, and much closer still to pronounce *u*.

It may be shown how all the vowels are pronounced with the farthest portion of the false palate which is above the epiglottis.

833.

If you draw in breath by the nose and send it out by the mouth you will hear the sound made by the division that is the membrane in [Footnote 5: The text here breaks off.]...

On the conditions of sight (834. 835).

834.

OF THE NATURE OF SIGHT.

I say that sight is exercised by all animals, by the medium of light; and if any one adduces, as against this, the sight of nocturnal animals, I must say that this in the same way is subject to the very same natural laws. For it will easily be understood that the senses which receive the images of things do not project from themselves any visual virtue [Footnote 4: Compare No. 68.]. On the contrary the atmospheric medium which exists between the object and the sense incorporates in itself the figure of things, and by its contact with the sense transmits the object to it. If the object — whether by sound or by odour — presents its spiritual force to the ear or the nose, then light is not required and does not act. The forms of objects do not send their images into the air if they are not illuminated ; and the eye being thus constituted cannot receive that from the air, which the air does not possess, although it touches its surface. If you choose to say that there are many animals that prey at night, I answer that when the little light which suffices the nature of their eyes is wanting, they direct themselves by their strong sense of hearing and of smell, which are not impeded by the darkness, and in which they are very far superior to man. If you make a cat leap, by daylight, among a quantity of jars and crocks you will see them remain unbroken, but if you do the same at night, many will be broken. Night birds do not fly about unless the moon shines full or in part; rather do they feed between sun-down and the total darkness of the night.

[Footnote 8: See No. 58-67.]

No body can be apprehended without light and shade, and light and shade are caused by light.

835.

WHY MEN ADVANCED IN AGE SEE BETTER AT A DISTANCE.

Sight is better from a distance than near in those men who are advancing in age, because the same object transmits a smaller impression of itself to the eye when it is distant than when it is near.

The seat of the common sense.

836.

The Common Sense, is that which judges of things offered to it by the other senses. The ancient speculators have concluded that that part of man which constitutes his judgment is caused by a central organ to which the other five senses refer everything by means of impressibility; and to this centre they have given the name Common Sense. And they say that this Sense is situated in the centre of the head between Sensation and Memory. And this name of Common Sense is given to it solely because it is the common judge of all the other five senses *i.e.* Seeing, Hearing, Touch, Taste and Smell. This Common Sense is acted upon by means of Sensation which is placed as a medium between it and the senses. Sensation is acted upon by means of the images of things presented to it by the external instruments, that is to say the senses which are the medium between external things and Sensation. In the same way the senses are acted upon by objects. Surrounding things transmit their images to the senses and the senses transfer them to the Sensation. Sensation sends them to the Common Sense, and by it they are stamped upon the memory and are there more or less retained according to the importance or force of the impression. That sense is most rapid in its function which is nearest to the sensitive medium and the eye, being the highest is the chief of the others. Of this then only we will speak, and the others we will leave in order not to make our matter too long. Experience tells us that the eye apprehends ten different natures of things, that is: Light and Darkness, one being the cause of the perception of the nine others, and the other its absence: — Colour and substance, form and place, distance and nearness, motion and stillness [Footnote 15: Compare No. 23.].

On the origin of the soul.

837.

Though human ingenuity may make various inventions which, by the help of various machines answering the same end, it will never devise any inventions more beautiful, nor more simple, nor more to the purpose than Nature does;

because in her inventions nothing is wanting, and nothing is superfluous, and she needs no counterpoise when she makes limbs proper for motion in the bodies of animals. But she puts into them the soul of the body, which forms them that is the soul of the mother which first constructs in the womb the form of the man and in due time awakens the soul that is to inhabit it. And this at first lies dormant and under the tutelage of the soul of the mother, who nourishes and vivifies it by the umbilical vein, with all its spiritual parts, and this happens because this umbilicus is joined to the placenta and the cotyledons, by which the child is attached to the mother. And these are the reason why a wish, a strong craving or a fright or any other mental suffering in the mother, has more influence on the child than on the mother; for there are many cases when the child loses its life from them, &c.

This discourse is not in its place here, but will be wanted for the one on the composition of animated bodies — and the rest of the definition of the soul I leave to the imaginations of friars, those fathers of the people who know all secrets by inspiration.

[Footnote 57: *lettere incoronate*. By this term Leonardo probably understands not the Bible only, but the works of the early Fathers, and all the books recognised as sacred by the Roman Church.] I leave alone the sacred books; for they are supreme truth.

On the relations of the soul to the organs of sense.

838.

HOW THE FIVE SENSES ARE THE MINISTERS OF THE SOUL.

The soul seems to reside in the judgment, and the judgment would seem to be seated in that part where all the senses meet; and this is called the Common Sense and is not all-pervading throughout the body, as many have thought. Rather is it entirely in one part. Because, if it were all-pervading and the same in every part, there would have been no need to make the instruments of the senses meet in one centre and in one single spot; on the contrary it would have sufficed that the eye should fulfil the function of its sensation on its surface only, and not transmit the image of the things seen, to the sense, by means of the optic nerves, so that the soul — for the reason given above — may perceive it in the surface of the eye. In the same way as to the sense of hearing, it would have sufficed if

the voice had merely sounded in the porous cavity of the indurated portion of the temporal bone which lies within the ear, without making any farther transit from this bone to the common sense, where the voice confers with and discourses to the common judgment. The sense of smell, again, is compelled by necessity to refer itself to that same judgment. Feeling passes through the perforated cords and is conveyed to this common sense. These cords diverge with infinite ramifications into the skin which encloses the members of the body and the viscera. The perforated cords convey volition and sensation to the subordinate limbs. These cords and the nerves direct the motions of the muscles and sinews, between which they are placed; these obey, and this obedience takes effect by reducing their thickness; for in swelling, their length is reduced, and the nerves shrink which are interwoven among the particles of the limbs; being extended to the tips of the fingers, they transmit to the sense the object which they touch.

The nerves with their muscles obey the tendons as soldiers obey the officers, and the tendons obey the Common [central] Sense as the officers obey the general. Thus the joint of the bones obeys the nerve, and the nerve the muscle, and the muscle the tendon and the tendon the Common Sense. And the Common Sense is the seat of the soul, and memory is its ammunition, and the impressibility is its referendary since the sense waits on the soul and not the soul on the sense. And where the sense that ministers to the soul is not at the service of the soul, all the functions of that sense are also wanting in that man's life, as is seen in those born mute and blind.

[Footnote: The peculiar use of the words *nervo*, *muscolo*, *corda*, *senso comune*, which are here literally rendered by nerve, muscle cord or tendon and Common Sense may be understood from lines 27 and 28.]

On involuntary muscular action.

839.

HOW THE NERVES SOMETIMES ACT OF THEMSELVES WITHOUT ANY COMMANDS FROM THE OTHER FUNCTIONS OF THE SOUL.

This is most plainly seen; for you will see palsied and shivering persons move,

and their trembling limbs, as their head and hands, quake without leave from their soul and their soul with all its power cannot prevent their members from trembling. The same thing happens in falling sickness, or in parts that have been cut off, as in the tails of lizards. The idea or imagination is the helm and guiding-rein of the senses, because the thing conceived of moves the sense. Pre-imagining, is imagining the things that are to be. Post-imagining, is imagining the things that are past.

Miscellaneous physiological observations (840-842).

840.

There are four Powers: memory and intellect, desire and covetousness. The two first are mental and the others sensual. The three senses: sight, hearing and smell cannot well be prevented; touch and taste not at all. Smell is connected with taste in dogs and other gluttonous animals.

841.

I reveal to men the origin of the first, or perhaps second cause of their existence.

842.

Lust is the cause of generation.

Appetite is the support of life. Fear or timidity is the prolongation of life and preservation of its instruments.

The laws of nutrition and the support of life (843-848).

843.

HOW THE BODY OF ANIMALS IS CONSTANTLY DYING AND BEING RENEWED.

The body of any thing whatever that takes nourishment constantly dies and is constantly renewed; because nourishment can only enter into places where the former nourishment has expired, and if it has expired it no longer has life. And if you do not supply nourishment equal to the nourishment which is gone, life will fail in vigour, and if you take away this nourishment, the life is entirely destroyed. But if you restore as much is destroyed day by day, then as much of the life is renewed as is consumed, just as the flame of the candle is fed by the nourishment afforded by the liquid of this candle, which flame continually with a rapid supply restores to it from below as much as is consumed in dying above: and from a brilliant light is converted in dying into murky smoke; and this death is continuous, as the smoke is continuous; and the continuance of the smoke is equal to the continuance of the nourishment, and in the same instant all the flame is dead and all regenerated, simultaneously with the movement of its own nourishment.

844.

King of the animals — as thou hast described him — I should rather say king of the beasts, thou being the greatest — because thou hast spared slaying them, in order that they may give thee their children for the benefit of the gullet, of which thou hast attempted to make a sepulchre for all animals; and I would say still more, if it were allowed me to speak the entire truth . But we do not go outside human matters in telling of one supreme wickedness, which does not happen among the animals of the earth, inasmuch as among them are found none who eat their own kind, unless through want of sense (few indeed among them, and those being mothers, as with men, albeit they be not many in number); and this happens only among the rapacious animals, as with the leonine species, and leopards, panthers lynxes, cats and the like, who sometimes eat their children; but thou, besides thy children devourest father, mother, brothers and friends; nor is this enough for thee, but thou goest to the chase on the islands of others, taking other men and these half-naked, the ... and the ... thou fattenest, and chasest them down thy own throat; now does not nature produce enough simples, for thee to satisfy thyself? and if thou art not content with simples, canst thou not by the mixture of them make infinite compounds, as Platina wrote[Footnote 21: *Come scrisse il Platina* (Bartolomeo Sacchi, a famous humanist). The Italian edition of his treatise *De arte coquinaria*, was published under the title *De la honesta voluptate, e valetudine*, Venezia 1487.], and other authors on feeding?

[Footnote: We are led to believe that Leonardo himself was a vegetarian from the following interesting passage in the first of Andrea Corsali's letters to Giuliano de' Medici: *Alcuni gentili chiamati Guzzarati non si cibano di cosa, alcuna che tenga sangue, ne fra essi loro consentono che si noccia ad alcuna cosa animata, come il nostro Leonardo da Vinci.*

5-18. Amerigo Vespucci, with whom Leonardo was personally acquainted, writes in his second letter to Pietro Soderini, about the inhabitants of the Canary Islands after having stayed there in 1503: "*Hanno una scelerata liberta di viuere; ... si cibano di carne humana, di maniera che il padre magia il figliuolo, et all'incontro il figliuolo il padre secondo che a caso e per sorte auiene. Io viddi un certo huomo sceleratissimo che si vantaua, et si teneua a non piccola gloria di hauer mangiato piu di trecento huomini. Viddi anche vna certa citta, nella quale io dimorai forse ventisette giorni, doue le carni humane, hauendole salate, eran appicate alli traui, si come noi alli traui di cucina appicchiamo le carni di cinghali secche al sole o al fumo, et massimamente salsiccie, et altre simil cose: anzi si marauigliauano gradem ete che noi non magiaissimo della carne de nemici, le quali dicono muouere appetito, et essere di marauiglioso sapore, et le lodano come cibi soauu et delicati (Lettere due di Amerigo Vespucci Fiorentino drizzate al magnifico Pietro Soderini, Gonfaloniere della eccelsa Republica di Firenze; various editions).*]

845.

Our life is made by the death of others.

In dead matter insensible life remains, which, reunited to the stomachs of living beings, resumes life, both sensual and intellectual.

846.

Here nature appears with many animals to have been rather a cruel stepmother than a mother, and with others not a stepmother, but a most tender mother.

847.

Man and animals are really the passage and the conduit of food, the sepulchre of animals and resting place of the dead, one causing the death of the other,

making themselves the covering for the corruption of other dead [bodies].
On the circulation of the blood (848-850).

848.

Death in old men, when not from fever, is caused by the veins which go from the spleen to the valve of the liver, and which thicken so much in the walls that they become closed up and leave no passage for the blood that nourishes it.

The incessant current of the blood through the veins makes these veins thicken and become callous, so that at last they close up and prevent the passage of the blood.

849.

The waters return with constant motion from the lowest depths of the sea to the utmost height of the mountains, not obeying the nature of heavier bodies; and in this they resemble the blood of animated beings which always moves from the sea of the heart and flows towards the top of the head; and here it may burst a vein, as may be seen when a vein bursts in the nose; all the blood rises from below to the level of the burst vein. When the water rushes out from the burst vein in the earth, it obeys the law of other bodies that are heavier than the air since it always seeks low places.

[Footnote: From this passage it is quite plain that Leonardo had not merely a general suspicion of the circulation of the blood but a very clear conception of it. Leonardo's studies on the muscles of the heart are to be found in the MS. W. An. III. but no information about them has hitherto been made public. The limits of my plan in this work exclude all purely anatomical writings, therefore only a very brief excerpt from this note book can be given here. WILLIAM HARVEY (born 1578 and Professor of Anatomy at Cambridge from 1615) is always considered to have been the discoverer of the circulation of the blood. He studied medicine at Padua in 1598, and in 1628 brought out his memorable and important work: *De motu cordis et sanguinis*.]

850.

That the blood which returns when the heart opens again is not the same as

that which closes the valves of the heart.
Some notes on medicine (851-855).

851.

Make them give you the definition and remedies for the case ... and you will see that men are selected to be doctors for diseases they do not know.

852.

A remedy for scratches taught me by the Herald to the King of France. 4 ounces of virgin wax, 4 ounces of colophony, 2 ounces of incense. Keep each thing separate; and melt the wax, and then put in the incense and then the colophony, make a mixture of it and put it on the sore place.

853.

Medicine is the restoration of discordant elements; sickness is the discord of the elements infused into the living body.

854.

Those who are annoyed by sickness at sea should drink extract of wormwood.

855.

To keep in health, this rule is wise: Eat only when you want and relish food. Chew thoroughly that it may do you good. Have it well cooked, unspiced and undisguised. He who takes medicine is ill advised.

[Footnote: This appears to be a sketch for a poem.]

856.

I teach you to preserve your health; and in this you will succeed better in

proportion as you shun physicians, because their medicines are the work of alchemists.

[Footnote: This passage is written on the back of the drawing Pl. CVIII. Compare also No. 1184.]

XV. ASTRONOMY.

Ever since the publication by Venturi in 1797 and Libri in 1840 of some few passages of Leonardo's astronomical notes, scientific astronomers have frequently expressed the opinion, that they must have been based on very important discoveries, and that the great painter also deserved a conspicuous place in the history of this science. In the passages here printed, a connected view is given of his astronomical studies as they lie scattered through the manuscripts, which have come down to us. Unlike his other purely scientific labours, Leonardo devotes here a good deal of attention to the opinions of the ancients, though he does not follow the practice universal in his day of relying on them as authorities; he only quotes them, as we shall see, in order to refute their arguments. His researches throughout have the stamp of independent thought. There is nothing in these writings to lead us to suppose that they were merely an epitome of the general learning common to the astronomers of the period. As early as in the XIVth century there were chairs of astronomy in the universities of Padua and Bologna, but so late as during the entire XVIth century Astronomy and Astrology were still closely allied.

It is impossible now to decide whether Leonardo, when living in Florence, became acquainted in his youth with the doctrines of Paolo Toscanelli the great astronomer and mathematician (died 1482), of whose influence and teaching but little is now known, beyond the fact that he advised and encouraged Columbus to carry out his project of sailing round the world. His name is nowhere mentioned by Leonardo, and from the dates of the manuscripts from which the texts on astronomy are taken, it seems highly probable that Leonardo devoted his attention to astronomical studies less in his youth than in his later years. It was evidently his purpose to treat of Astronomy in a connected form and in a separate work (see the beginning of Nos. 866 and 892; compare also No. 1167). It is quite in accordance with his general scientific thoroughness that he should propose to write a special treatise on Optics as an introduction to Astronomy (see Nos. 867 and 877). Some of the chapters belonging to this Section bear the title "Prospettiva" (see Nos. 869 and 870), this being the term universally applied at the time to Optics as well as Perspective (see Vol. I, p. 10, note to No. 13, l. 10).

At the beginning of the XVIth century the Ptolemaic theory of the universe was

still universally accepted as the true one, and Leonardo conceives of the earth as fixed, with the moon and sun revolving round it, as they are represented in the diagram to No. 897. He does not go into any theory of the motions of the planets; with regard to these and the fixed stars he only investigates the phenomena of their luminosity. The spherical form of the earth he takes for granted as an axiom from the first, and he anticipates Newton by pointing out the universality of Gravitation not merely in the earth, but even in the moon. Although his acute research into the nature of the moon's light and the spots on the moon did not bring to light many results of lasting importance beyond making it evident that they were a refutation of the errors of his contemporaries, they contain various explanations of facts which modern science need not modify in any essential point, and discoveries which history has hitherto assigned to a very much later date.

The ingenious theory by which he tries to explain the nature of what is known as earth shine, the reflection of the sun's rays by the earth towards the moon, saying that it is a peculiar refraction, originating in the innumerable curved surfaces of the waves of the sea may be regarded as absurd; but it must not be forgotten that he had no means of detecting the fundamental error on which he based it, namely: the assumption that the moon was at a relatively short distance from the earth. So long as the motion of the earth round the sun remained unknown, it was of course impossible to form any estimate of the moon's distance from the earth by a calculation of its parallax.

Before the discovery of the telescope accurate astronomical observations were only possible to a very limited extent. It would appear however from certain passages in the notes here printed for the first time, that Leonardo was in a position to study the spots in the moon more closely than he could have done with the unaided eye. So far as can be gathered from the mysterious language in which the description of his instrument is wrapped, he made use of magnifying glasses; these do not however seem to have been constructed like a telescope — telescopes were first made about 1600. As LIBRI pointed out (Histoire des Sciences mathematiques III, 101) Fracastoro of Verona (1473-1553) succeeded in magnifying the moon's face by an arrangement of lenses (compare No. 910, note), and this gives probability to Leonardo's invention at a not much earlier date.

I.

THE EARTH AS A PLANET.

The earth's place in the universe (857. 858).

857.

The equator, the line of the horizon, the ecliptic, the meridian:

These lines are those which in all their parts are equidistant from the centre of the globe.

858.

The earth is not in the centre of the Sun's orbit nor at the centre of the universe, but in the centre of its companion elements, and united with them. And any one standing on the moon, when it and the sun are both beneath us, would see this our earth and the element of water upon it just as we see the moon, and the earth would light it as it lights us.

The fundamental laws of the solar system (859-864).

859.

Force arises from dearth or abundance; it is the child of physical motion, and the grand-child of spiritual motion, and the mother and origin of gravity. Gravity is limited to the elements of water and earth; but this force is unlimited, and by it infinite worlds might be moved if instruments could be made by which the force could be generated.

Force, with physical motion, and gravity, with resistance are the four external powers on which all actions of mortals depend.

Force has its origin in spiritual motion; and this motion, flowing through the limbs of sentient animals, enlarges their muscles. Being enlarged by this current the muscles are shrunk in length and contract the tendons which are connected with them, and this is the cause of the force of the limbs in man.

The quality and quantity of the force of a man are able to give birth to other forces, which will be proportionally greater as the motions produced by them last longer.

[Footnote: Only part of this passage belongs, strictly speaking, to this section. The principle laid down in the second paragraph is more directly connected with

the notes given in the preceding section on Physiology.]

860.

Why does not the weight *o* remain in its place? It does not remain because it has no resistance. Where will it move to? It will move towards the centre [of gravity]. And why by no other line? Because a weight which has no support falls by the shortest road to the lowest point which is the centre of the world. And why does the weight know how to find it by so short a line? Because it is not independant and does not move about in various directions.

[Footnote: This text and the sketch belonging to it, are reproduced on Pl. CXXI.]

861.

Let the earth turn on which side it may the surface of the waters will never move from its spherical form, but will always remain equidistant from the centre of the globe.

Granting that the earth might be removed from the centre of the globe, what would happen to the water?

It would remain in a sphere round that centre equally thick, but the sphere would have a smaller diameter than when it enclosed the earth.

[Footnote: Compare No. 896, lines 48-64; and No. 936.]

862.

Supposing the earth at our antipodes which supports the ocean were to rise and stand uncovered, far out of the sea, but remaining almost level, by what means afterwards, in the course of time, would mountains and vallies be formed?

And the rocks with their various strata?

863.

Each man is always in the middle of the surface of the earth and under the zenith of his own hemisphere, and over the centre of the earth.

864.

Mem.: That I must first show the distance of the sun from the earth; and, by means of a ray passing through a small hole into a dark chamber, detect its real size; and besides this, by means of the aqueous sphere calculate the size of the globe ...

Here it will be shown, that when the sun is in the meridian of our hemisphere [Footnote 10: *Antipodi orientali cogli occidentali*. The word *Antipodes* does not here bear its literal sense, but — as we may infer from the simultaneous reference to inhabitants of the North and South — is used as meaning men living at a distance of 90 degrees from the zenith of the rational horizon of each observer.], the antipodes to the East and to the West, alike, and at the same time, see the sun mirrored in their waters; and the same is equally true of the arctic and antarctic poles, if indeed they are inhabited.

How to prove that the earth is a planet (865-867).

865.

That the earth is a star.

866.

In your discourse you must prove that the earth is a star much like the moon, and the glory of our universe; and then you must treat of the size of various stars, according to the authors.

867.

THE METHOD OF PROVING THAT THE EARTH IS A STAR.

First describe the eye; then show how the twinkling of a star is really in the eye and why one star should twinkle more than another, and how the rays from the stars originate in the eye; and add, that if the twinkling of the stars were really in

the stars — as it seems to be — that this twinkling appears to be an extension as great as the diameter of the body of the star; therefore, the star being larger than the earth, this motion effected in an instant would be a rapid doubling of the size of the star. Then prove that the surface of the air where it lies contiguous to fire, and the surface of the fire where it ends are those into which the solar rays penetrate, and transmit the images of the heavenly bodies, large when they rise, and small, when they are on the meridian. Let *a* be the earth and *n d m* the surface of the air in contact with the sphere of fire; *h f g* is the orbit of the moon or, if you please, of the sun; then I say that when the sun appears on the horizon *g*, its rays are seen passing through the surface of the air at a slanting angle, that is *o m*; this is not the case at *d k*. And so it passes through a greater mass of air; all of *e m* is a denser atmosphere.

868.

Beyond the sun and us there is darkness and so the air appears blue.

[Footnote: Compare Vol. I, No. 301.]

869.

PERSPECTIVE.

It is possible to find means by which the eye shall not see remote objects as much diminished as in natural perspective, which diminishes them by reason of the convexity of the eye which necessarily intersects, at its surface, the pyramid of every image conveyed to the eye at a right angle on its spherical surface. But by the method I here teach in the margin these pyramids are intersected at right angles close to the surface of the pupil. The convex pupil of the eye can take in the whole of our hemisphere, while this will show only a single star; but where many small stars transmit their images to the surface of the pupil those stars are extremely small; here only one star is seen but it will be large. And so the moon will be seen larger and its spots of a more defined form [Footnote 20 and fol.: Telescopes were not in use till a century later. Compare No. 910 and page 136.]. You must place close to the eye a glass filled with the water of which mention is made in number 4 of Book 113 “On natural substances” [Footnote 23: *libro* 113.

This is perhaps the number of a book in some library catalogue. But it may refer, on the other hand, to one of the 120 Books mentioned in No. 796. l. 84.]; for this water makes objects which are enclosed in balls of crystalline glass appear free from the glass.

OF THE EYE.

Among the smaller objects presented to the pupil of the eye, that which is closest to it, will be least appreciable to the eye. And at the same time, the experiments here made with the power of sight, show that it is not reduced to speck if the &c. [Footnote 32: Compare with this the passage in Vol. I, No. 52, written about twenty years earlier.].

Read in the margin.

Those objects are seen largest which come to the eye at the largest angles.

But the images of the objects conveyed to the pupil of the eye are distributed to the pupil exactly as they are distributed in the air: and the proof of this is in what follows; that when we look at the starry sky, without gazing more fixedly at one star than another, the sky appears all strewn with stars; and their proportions to the eye are the same as in the sky and likewise the spaces between them .

[Footnote: 9. 32. *in margine*: lines 34-61 are, in the original, written on the margin and above them is the diagram to which Leonardo seems to refer here.]

870.

PERSPECTIVE.

Among objects moved from the eye at equal distance, that undergoes least diminution which at first was most remote.

When various objects are removed at equal distances farther from their original position, that which was at first the farthest from the eye will diminish least. And the proportion of the diminution will be in proportion to the relative distance of the objects from the eye before they were removed.

That is to say in the object *t* and the object *e* the proportion of their distances from the eye *a* is quintuple. I remove each from its place and set it farther from

the eye by one of the 5 parts into which the proposition is divided. Hence it happens that the nearest to the eye has doubled the distance and according to the last proposition but one of this, is diminished by the half of its whole size; and the body *e*, by the same motion, is diminished 1/5 of its whole size. Therefore, by that same last proposition but one, that which is said in this last proposition is true; and this I say of the motions of the celestial bodies which are more distant by 3500 miles when setting than when overhead, and yet do not increase or diminish in any sensible degree.

871.

a b is the aperture through which the sun passes, and if you could measure the size of the solar rays at *n m*, you could accurately trace the real lines of the convergence of the solar rays, the mirror being at *a b*, and then show the reflected rays at equal angles to *n m*; but, as you want to have them at *n m*, take them at the inner side of the aperture at *cd*, where they maybe measured at the spot where the solar rays fall. Then place your mirror at the distance *a b*, making the rays *d b*, *c a* fall and then be reflected at equal angles towards *c d*; and this is the best method, but you must use this mirror always in the same month, and the same day, and hour and instant, and this will be better than at no fixed time because when the sun is at a certain distance it produces a certain pyramid of rays.

872.

a, the side of the body in light and shade *b*, faces the whole portion of the hemisphere bed *e f*, and does not face any part of the darkness of the earth. And the same occurs at the point *o*; therefore the space *a o* is throughout of one and the same brightness, and *s* faces only four degrees of the hemisphere *d e f g h*, and also the whole of the earth *s h*, which will render it darker; and how much must be demonstrated by calculation. [Footnote: This passage, which has perhaps a doubtful right to its place in this connection, stands in the Manuscript between those given in Vol. I as No. 117 and No. 427.]

873.

THE REASON OF THE INCREASED SIZE OF THE SUN IN THE WEST.

Some mathematicians explain that the sun looks larger as it sets, because the eye always sees it through a denser atmosphere, alleging that objects seen through mist or through water appear larger. To these I reply: No; because objects seen through a mist are similar in colour to those at a distance; but not being similarly diminished they appear larger. Again, nothing increases in size in smooth water; and the proof of this may be seen by throwing a light on a board placed half under water. But the reason why the sun looks larger is that every luminous body appears larger in proportion as it is more remote. [Footnote: Lines 5 and 6 are thus rendered by M. RAVAISSON in his edition of MS. A. “*De meme, aucune chose ne croit dans l’eau plane, et tu en feras l’experience en calquant un ais sous l’eau.*” — Compare the diagrams in Vol. I, p. 114.]

On the luminosity of the Earth in the universal space (874-878).

874.

In my book I propose to show, how the ocean and the other seas must, by means of the sun, make our world shine with the appearance of a moon, and to the remoter worlds it looks like a star; and this I shall prove.

Show, first that every light at a distance from the eye throws out rays which appear to increase the size of the luminous body; and from this it follows that 2 ...[Footnote 10: Here the text breaks off; lines 11 and fol. are written in the margin.].

The moon is cold and moist. Water is cold and moist. Thus our seas must appear to the moon as the moon does to us.

875.

The waves in water magnify the image of an object reflected in it.

Let a be the sun, and n m the ruffled water, b the image of the sun when the water is smooth. Let f be the eye which sees the image in all the waves included within the base of the triangle $c e f$. Now the sun reflected in the unruffled surface occupied the space $c d$, while in the ruffled surface it covers all the watery space $c e$ (as is proved in the 4th of my “Perspective”) [Footnote 9: *Nel*

quarto della mia prospettiva. If this reference is to the diagrams accompanying the text — as is usual with Leonardo — and not to some particular work, the largest of the diagrams here given must be meant. It is the lowest and actually the fifth, but he would have called it the fourth, for the text here given is preceded on the same page of the manuscript by a passage on whirlpools, with the diagram belonging to it also reproduced here. The words *della mia prospettiva* may therefore indicate that the diagram to the preceding chapter treating on a heterogeneous subject is to be excluded. It is a further difficulty that this diagram belongs properly to lines 9-10 and not to the preceding sentence. The reflection of the sun in water is also discussed in the Theoretical part of the Book on Painting; see Vol. I, No. 206, 207.] and it will cover more of the water in proportion as the reflected image is remote from the eye .

[Footnote: In the original sketch, inside the circle in the first diagram, is written *Sole* (sun), and to the right of it *luna* (moon). Thus either of these heavenly bodies may be supposed to fill that space. Within the lower circle is written *simulacro* (image). In the two next diagrams at the spot here marked *L* the word *Luna* is written, and in the last *sole* is written in the top circle at *a*.]

The image of the sun will be more brightly shown in small waves than in large ones — and this is because the reflections or images of the sun are more numerous in the small waves than in large ones, and the more numerous reflections of its radiance give a larger light than the fewer.

Waves which intersect like the scales of a fir cone reflect the image of the sun with the greatest splendour; and this is the case because the images are as many as the ridges of the waves on which the sun shines, and the shadows between these waves are small and not very dark; and the radiance of so many reflections together becomes united in the image which is transmitted to the eye, so that these shadows are imperceptible.

That reflection of the sun will cover most space on the surface of the water which is most remote from the eye which sees it.

Let *a* be the sun, *p q* the reflection of the sun; *a b* is the surface of the water, in which the sun is mirrored, and *r* the eye which sees this reflection on the surface of the water occupying the space *o m*. *c* is the eye at a greater distance from the surface of the water and also from the reflection; hence this reflection covers a larger space of water, by the distance between *n* and *o*.

876.

It is impossible that the side of a spherical mirror, illuminated by the sun,

should reflect its radiance unless this mirror were undulating or filled with bubbles.

You see here the sun which lights up the moon, a spherical mirror, and all of its surface, which faces the sun is rendered radiant.

Whence it may be concluded that what shines in the moon is water like that of our seas, and in waves as that is; and that portion which does not shine consists of islands and terra firma.

This diagram, of several spherical bodies interposed between the eye and the sun, is given to show that, just as the reflection of the sun is seen in each of these bodies, in the same way that image may be seen in each curve of the waves of the sea; and as in these many spheres many reflections of the sun are seen, so in many waves there are many images, each of which at a great distance is much magnified to the eye. And, as this happens with each wave, the spaces interposed between the waves are concealed; and, for this reason, it looks as though the many suns mirrored in the many waves were but one continuous sun; and the shadows,, mixed up with the luminous images, render this radiance less brilliant than that of the sun mirrored in these waves.

[Footnote: In the original, at letter *A* in the diagram “*Sole*” (the sun) is written, and at *o* “*occhio*” (the eye).]

877.

This will have before it the treatise on light and shade.

The edges in the moon will be most strongly lighted and reflect most light, because, there, nothing will be visible but the tops of the waves of the water [Footnote 5: I have thought it unnecessary to reproduce the detailed explanation of the theory of reflection on waves contained in the passage which follows this.].

878.

The sun will appear larger in moving water or on waves than in still water; an example is the light reflected on the strings of a monochord.

II.

THE SUN.

The question of the true and of the apparent size of the sun (879-884).

879.

IN PRAISE OF THE SUN.

If you look at the stars, cutting off the rays (as may be done by looking through a very small hole made with the extreme point of a very fine needle, placed so as almost to touch the eye), you will see those stars so minute that it would seem as though nothing could be smaller; it is in fact their great distance which is the reason of their diminution, for many of them are very many times larger than the star which is the earth with water. Now reflect what this our star must look like at such a distance, and then consider how many stars might be added — both in longitude and latitude — between those stars which are scattered over the darkened sky. But I cannot forbear to condemn many of the ancients, who said that the sun was no larger than it appears; among these was Epicurus, and I believe that he founded his reason on the effects of a light placed in our atmosphere equidistant from the centre of the earth. Any one looking at it never sees it diminished in size at whatever distance; and the rea-

[Footnote 879-882: What Leonardo says of Epicurus — who according to LEWIS, *The Astronomy of the ancients*, and MADLER, *Geschichte der Himmelskunde*, did not devote much attention to the study of celestial phenomena — , he probably derived from Book X of Diogenes Laertius, whose *Vitae Philosophorum* was not printed in Greek till 1533, but the Latin translation appeared in 1475.]

880.

sons of its size and power I shall reserve for Book 4. But I wonder greatly that Socrates

[Footnote 2: *Socrates*; I have little light to throw on this reference. Plato's Socrates himself declares on more than one occasion that in his youth he had turned his mind to the study of celestial phenomena (METEWPA) but not in his later years (see G. C. LEWIS, *The Astronomy of the ancients*, page 109; MADLER, *Geschichte der Himmelskunde*, page 41). Here and there in Plato's

writings we find incidental notes on the sun and other heavenly bodies. Leonardo may very well have known of these, since the Latin version by Ficinus was printed as early as 1491; indeed an undated edition exists which may very likely have appeared between 1480 — 90.

There is but one passage in Plato, *Epinomis* (p. 983) where he speaks of the physical properties of the sun and says that it is larger than the earth.

Aristotle who goes very fully into the subject says the same. A complete edition of Aristotele's works was first printed in Venice 1495-98, but a Latin version of the Books *De Coelo et Mundo* and *De Physica* had been printed in Venice as early as in 1483 (H. MULLER-STRUBING).]

should have depreciated that solar body, saying that it was of the nature of incandescent stone, and the one who opposed him as to that error was not far wrong. But I only wish I had words to serve me to blame those who are fain to extol the worship of men more than that of the sun; for in the whole universe there is nowhere to be seen a body of greater magnitude and power than the sun. Its light gives light to all the celestial bodies which are distributed throughout the universe; and from it descends all vital force, for the heat that is in living beings comes from the soul [vital spark]; and there is no other centre of heat and light in the universe as will be shown in Book 4; and certainly those who have chosen to worship men as gods — as Jove, Saturn, Mars and the like — have fallen into the gravest error, seeing that even if a man were as large as our earth, he would look no bigger than a little star which appears but as a speck in the universe; and seeing again that these men are mortal, and putrid and corrupt in their sepulchres.

Marcellus [Footnote 23: I have no means of identifying *Marcello* who is named in the margin. It may be Nonius Marcellus, an obscure Roman Grammarian of uncertain date (between the IInd and Vth centuries A. C.) the author of the treatise *De compendiosa doctrina per litteras ad filium* in which he treats *de rebus omnibus et quibusdam aliis*. This was much read in the middle ages. The *editto princeps* is dated 1470 (H. MULLER-STRUBING).] and many others praise the sun.

881.

Epicurus perhaps saw the shadows cast by columns on the walls in front of them equal in diameter to the columns from which the shadows were cast; and the breadth of the shadows being parallel from beginning to end, he thought he might infer that the sun also was directly opposite to this parallel and that

consequently its breadth was not greater than that of the column; not perceiving that the diminution in the shadow was insensibly slight by reason of the remoteness of the sun. If the sun were smaller than the earth, the stars on a great portion of our hemisphere would have no light, which is evidence against Epicurus who says the sun is only as large as it appears.

[Footnote: In the original the writing is across the diagram.]

882.

Epicurus says the sun is the size it looks. Hence as it looks about a foot across we must consider that to be its size; it would follow that when the moon eclipses the sun, the sun ought not to appear the larger, as it does. Then, the moon being smaller than the sun, the moon must be less than a foot, and consequently when our world eclipses the moon, it must be less than a foot by a finger's breadth; inasmuch as if the sun is a foot across, and our earth casts a conical shadow on the moon, it is inevitable that the luminous cause of the cone of shadow must be larger than the opaque body which casts the cone of shadow.

883.

To measure how many times the diameter of the sun will go into its course in 24 hours.

Make a circle and place it to face the south, after the manner of a sundial, and place a rod in the middle in such a way as that its length points to the centre of this circle, and mark the shadow cast in the sunshine by this rod on the circumference of the circle, and this shadow will be — let us say — as broad as from *a* to *n*. Now measure how many times this shadow will go into this circumference of a circle, and that will give you the number of times that the solar body will go into its orbit in 24 hours. Thus you may see whether Epicurus was [right in] saying that the sun was only as large as it looked; for, as the apparent diameter of the sun is about a foot, and as that sun would go a thousand times into the length of its course in 24 hours, it would have gone a thousand feet, that is 300 braccia, which is the sixth of a mile. Whence it would follow that the course of the sun during the day would be the sixth part of a mile and that this venerable snail, the sun will have travelled 25 braccia an hour.

884.

Posidonius composed books on the size of the sun. [Footnote: Poseidonius of Apamea, commonly called the Rhodian, because he taught in Rhodes, was a Stoic philosopher, a contemporary and friend of Cicero's, and the author of numerous works on natural science, among them.

Strabo quotes no doubt from one of his works, when he says that Poseidonius explained how it was that the sun looked larger when it was rising or setting than during the rest of its course (III, p. 135). Kleomedes, a later Greek Naturalist also mentions this observation of Poseidonius' without naming the title of his work; however, as Kleomedes' *Cyclia Theorica* was not printed till 1535, Leonardo must have derived his quotation from Strabo. He probably wrote this note in 1508, and as the original Greek was first printed in Venice in 1516, we must suppose him to quote here from the translation by Guarinus Veronensis, which was printed as early as 1471, also at Venice (H. MULLER-STRUBING).]

Of the nature of Sunlight.

885.

OF THE PROOF THAT THE SUN IS HOT BY NATURE AND NOT BY VIRTUE.

Of the nature of Sunlight.

That the heat of the sun resides in its nature and not in its virtue [or mode of action] is abundantly proved by the radiance of the solar body on which the human eye cannot dwell and besides this no less manifestly by the rays reflected from a concave mirror, which — when they strike the eye with such splendour that the eye cannot bear them — have a brilliancy equal to the sun in its own place. And that this is true I prove by the fact that if the mirror has its concavity formed exactly as is requisite for the collecting and reflecting of these rays, no created being could endure the heat that strikes from the reflected rays of such a mirror. And if you argue that the mirror itself is cold and yet send forth hot rays, I should reply that those rays come really from the sun and that it is the ray of the concave mirror after having passed through the window.

Considerations as to the size of the sun (886-891).

886.

The sun does not move. [Footnote: This sentence occurs incidentally among mathematical notes, and is written in unusually large letters.]

887.

**PROOF THAT THE NEARER YOU ARE TO THE
SOURCE OF THE SOLAR RAYS, THE LARGER
WILL THE REFLECTION OF THE SUN FROM
THE SEA APPEAR TO YOU.**

[Footnote: Lines 4 and fol. Compare Vol. I, Nos. 130, 131.] If it is from the centre that the sun employs its radiance to intensify the power of its whole mass, it is evident that the farther its rays extend, the more widely they will be divided; and this being so, you, whose eye is near the water that mirrors the sun, see but a small portion of the rays of the sun strike the surface of the water, and reflecting the form of the sun. But if you were near to the sun — as would be the case when the sun is on the meridian and the sea to the westward — you would see the sun, mirrored in the sea, of a very great size; because, as you are nearer to the sun, your eye taking in the rays nearer to the point of radiation takes more of them in, and a great splendour is the result. And in this way it can be proved that the moon must have seas which reflect the sun, and that the parts which do not shine are land.

888.

Take the measure of the sun at the solstice in mid-June.

889.

WHY THE SUN APPEARS LARGER WHEN

SETTING THAN AT NOON, WHEN IT IS NEAR TO US.

Every object seen through a curved medium seems to be of larger size than it is.
[Footnote: At A is written *sole* (the sun), at B *terra* (the earth).]

890.

Because the eye is small it can only see the image of the sun as of a small size. If the eye were as large as the sun it would see the image of the sun in water of the same size as the real body of the sun, so long as the water is smooth.

891.

A METHOD OF SEEING THE SUN ECLIPSED WITHOUT PAIN TO THE EYE.

Take a piece of paper and pierce holes in it with a needle, and look at the sun through these holes.

III.

THE MOON.

On the luminosity of the moon (892-901).

892.

OF THE MOON.

As I propose to treat of the nature of the moon, it is necessary that first I should describe the perspective of mirrors, whether plane, concave or convex; and first what is meant by a luminous ray, and how it is refracted by various kinds of media; then, when a reflected ray is most powerful, whether when the angle of incidence is acute, right, or obtuse, or from a convex, a plane, or a concave surface; or from an opaque or a transparent body. Besides this, how it is that the solar rays which fall on the waves of the sea, are seen by the eye of the same width at the angle nearest to the eye, as at the highest line of the waves on the horizon; but notwithstanding this the solar rays reflected from the waves of the sea assume the pyramidal form and consequently, at each degree of distance increase proportionally in size, although to our sight, they appear as parallel.

1st. Nothing that has very little weight is opaque.

2dly. Nothing that is excessively weighty can remain beneath that which is heavier.

3dly. As to whether the moon is situated in the centre of its elements or not.

And, if it has no proper place of its own, like the earth, in the midst of its elements, why does it not fall to the centre of our elements? [Footnote 26: The problem here propounded by Leonardo was not satisfactorily answered till Newton in 1682 formulated the law of universal attraction and gravitation. Compare No. 902, lines 5-15.]

And, if the moon is not in the centre of its own elements and yet does not fall, it must then be lighter than any other element.

And, if the moon is lighter than the other elements why is it opaque and not transparent?

When objects of various sizes, being placed at various distances, look of equal size, there must be the same relative proportion in the distances as in the magnitudes of the objects.

[Footnote: In the diagram Leonardo wrote *sole* at the place marked A.]

893.

OF THE MOON AND WHETHER IT IS POLISHED AND SPHERICAL.

The image of the sun in the moon is powerfully luminous, and is only on a small portion of its surface. And the proof may be seen by taking a ball of burnished gold and placing it in the dark with a light at some distance from it; and then,

although it will illuminate about half of the ball, the eye will perceive its reflection only in a small part of its surface, and all the rest of the surface reflects the darkness which surrounds it; so that it is only in that spot that the image of the light is seen, and all the rest remains invisible, the eye being at a distance from the ball. The same thing would happen on the surface of the moon if it were polished, lustrous and opaque, like all bodies with a reflecting surface.

Show how, if you were standing on the moon or on a star, our earth would seem to reflect the sun as the moon does.

And show that the image of the sun in the sea cannot appear one and undivided, as it appears in a perfectly plane mirror.

894.

How shadows are lost at great distances, as is shown by the shadow side of the moon which is never seen. [Footnote: Compare also Vol. I, Nos. 175-179.]

895.

Either the moon has intrinsic luminosity or not. If it has, why does it not shine without the aid of the sun? But if it has not any light in itself it must of necessity be a spherical mirror; and if it is a mirror, is it not proved in Perspective that the image of a luminous object will never be equal to the extent of surface of the reflecting body that it illuminates? And if it be thus [Footnote 13: At A, in the diagram, Leonardo wrote “*sole*” (the sun), and at B “*luna o noi terra*” (the moon or our earth). Compare also the text of No. 876.], as is here shown at *r s* in the figure, whence comes so great an extent of radiance as that of the full moon as we see it, at the fifteenth day of the moon?

896.

OF THE MOON.

The moon has no light in itself; but so much of it as faces the sun is illuminated, and of that illumined portion we see so much as faces the earth. And the moon's

night receives just as much light as is lent it by our waters as they reflect the image of the sun, which is mirrored in all those waters which are on the side towards the sun. The outside or surface of the waters forming the seas of the moon and of the seas of our globe is always ruffled little or much, or more or less — and this roughness causes an extension of the numberless images of the sun which are repeated in the ridges and hollows, the sides and fronts of the innumerable waves; that is to say in as many different spots on each wave as our eyes find different positions to view them from. This could not happen, if the aqueous sphere which covers a great part of the moon were uniformly spherical, for then the images of the sun would be one to each spectator, and its reflections would be separate and independent and its radiance would always appear circular; as is plainly to be seen in the gilt balls placed on the tops of high buildings. But if those gilt balls were rugged or composed of several little balls, like mulberries, which are a black fruit composed of minute round globules, then each portion of these little balls, when seen in the sun, would display to the eye the lustre resulting from the reflection of the sun, and thus, in one and the same body many tiny suns would be seen; and these often combine at a long distance and appear as one. The lustre of the new moon is brighter and stronger, than when the moon is full; and the reason of this is that the angle of incidence is more obtuse in the new than in the full moon, in which the angles [of incidence and reflection] are highly acute. The waves of the moon therefore mirror the sun in the hollows of the waves as well as on the ridges, and the sides remain in shadow. But at the sides of the moon the hollows of the waves do not catch the sunlight, but only their crests; and thus the images are fewer and more mixed up with the shadows in the hollows; and this intermingling of the shaded and illuminated spots comes to the eye with a mitigated splendour, so that the edges will be darker, because the curves of the sides of the waves are insufficient to reflect to the eye the rays that fall upon them. Now the new moon naturally reflects the solar rays more directly towards the eye from the crests of the waves than from any other part, as is shown by the form of the moon, whose rays strike the waves *b* and are reflected in the line *b d*, the eye being situated at *d*. This cannot happen at the full moon, when the solar rays, being in the west, fall on the extreme waters of the moon to the East from *n* to *m*, and are not reflected to the eye in the West, but are thrown back eastwards, with but slight deflection from the straight course of the solar ray; and thus the angle of incidence is very wide indeed.

The moon is an opaque and solid body and if, on the contrary, it were transparent, it would not receive the light of the sun.

The yellow or yolk of an egg remains in the middle of the albumen, without

moving on either side; now it is either lighter or heavier than this albumen, or equal to it; if it is lighter, it ought to rise above all the albumen and stop in contact with the shell of the egg; and if it is heavier, it ought to sink, and if it is equal, it might just as well be at one of the ends, as in the middle or below .

[Footnote 48-64: Compare No. 861.]

The innumerable images of the solar rays reflected from the innumerable waves of the sea, as they fall upon those waves, are what cause us to see the very broad and continuous radiance on the surface of the sea.

897.

That the sun could not be mirrored in the body of the moon, which is a convex mirror, in such a way as that so much of its surface as is illuminated by the sun, should reflect the sun unless the moon had a surface adapted to reflect it — in waves and ridges, like the surface of the sea when its surface is moved by the wind.

[Footnote: In the original diagrams *sole* is written at the place marked *A*; *luna* at *C*, and *terra* at the two spots marked *B*.]

The waves in water multiply the image of the object reflected in it.

These waves reflect light, each by its own line, as the surface of the fir cone does [Footnote 14: See the diagram p. 145.]

These are 2 figures one different from the other; one with undulating water and the other with smooth water.

It is impossible that at any distance the image of the sun cast on the surface of a spherical body should occupy the half of the sphere.

Here you must prove that the earth produces all the same effects with regard to the moon, as the moon with regard to the earth.

The moon, with its reflected light, does not shine like the sun, because the light of the moon is not a continuous reflection of that of the sun on its whole surface, but only on the crests and hollows of the waves of its waters; and thus the sun being confusedly reflected, from the admixture of the shadows that lie between the lustrous waves, its light is not pure and clear as the sun is.

[Footnote 38: This refers to the small diagram placed between *B* and *B*. —]. The earth between the moon on the fifteenth day and the sun. [Footnote 39: See the diagram below the one referred to in the preceding note.] Here the sun is in the East and the moon on the fifteenth day in the West. [Footnote 40.41: Refers to the diagram below the others.] The moon on the fifteenth [day] between the earth and the sun. Here it is the moon which has the sun to the West and the

earth to the East.

898.

WHAT SORT OF THING THE MOON IS.

The moon is not of itself luminous, but is highly fitted to assimilate the character of light after the manner of a mirror, or of water, or of any other reflecting body; and it grows larger in the East and in the West, like the sun and the other planets. And the reason is that every luminous body looks larger in proportion as it is remote. It is easy to understand that every planet and star is farther from us when in the West than when it is overhead, by about 3500 miles, as is proved on the margin [Footnote 7: refers to the first diagram. — A = *sole* (the sun), B = *terra* (the earth), C = *luna* (the moon).], and if you see the sun or moon mirrored in the water near to you, it looks to you of the same size in the water as in the sky. But if you recede to the distance of a mile, it will look 100 times larger; and if you see the sun reflected in the sea at sunset, its image would look to you more than 10 miles long; because that reflected image extends over more than 10 miles of sea. And if you could stand where the moon is, the sun would look to you, as if it were reflected from all the sea that it illuminates by day; and the land amid the water would appear just like the dark spots that are on the moon, which, when looked at from our earth, appears to men the same as our earth would appear to any men who might dwell in the moon.

[Footnote: This text has already been published by LIBRI: *Histoire des Sciences*, III, pp. 224, 225.]

OF THE NATURE OF THE MOON.

When the moon is entirely lighted up to our sight, we see its full daylight; and at that time, owing to the reflection of the solar rays which fall on it and are thrown off towards us, its ocean casts off less moisture towards us; and the less light it gives the more injurious it is.

899.

OF THE MOON.

I say that as the moon has no light in itself and yet is luminous, it is inevitable but that its light is caused by some other body.

900.

OF THE MOON.

All my opponent's arguments to say that there is no water in the moon.
[Footnote: The objections are very minutely noted down in the manuscript, but they hardly seem to have a place here.]

901.

Answer to Maestro Andrea da Imola, who said that the solar rays reflected from a convex mirror are mingled and lost at a short distance; whereby it is altogether denied that the luminous side of the moon is of the nature of a mirror, and that consequently the light is not produced by the innumerable multitude of the waves of that sea, which I declared to be the portion of the moon which is illuminated by the solar rays.

Let op be the body of the sun, cn the moon, and b the eye which, above the base cn of the cathetus cnm , sees the body of the sun reflected at equal angles c n ; and the same again on moving the eye from b to a . [Footnote: The large diagram on the margin of page 161 belongs to this chapter.]

Explanation of the lumen cinereum in the moon.

902.

OF THE MOON.

No solid body is less heavy than the atmosphere.

[Footnote: 1. On the margin are the words *tola romantina*, *tola — ferro stagnato* (tinned iron); *romantina* is some special kind of sheet-iron no longer known by that name.]

Having proved that the part of the moon that shines consists of water, which mirrors the body of the sun and reflects the radiance it receives from it; and that, if these waters were devoid of waves, it would appear small, but of a radiance almost like the sun; — It must now be shown whether the moon is a heavy or a light body: for, if it were a heavy body — admitting that at every grade of distance from the earth greater levity must prevail, so that water is lighter than the earth, and air than water, and fire than air and so on successively — it would seem that if the moon had density as it really has, it would have weight, and having weight, that it could not be sustained in the space where it is, and consequently that it would fall towards the centre of the universe and become united to the earth; or if not the moon itself, at least its waters would fall away and be lost from it, and descend towards the centre, leaving the moon without any and so devoid of lustre. But as this does not happen, as might in reason be expected, it is a manifest sign that the moon is surrounded by its own elements: that is to say water, air and fire; and thus is, of itself and by itself, suspended in that part of space, as our earth with its element is in this part of space; and that heavy bodies act in the midst of its elements just as other heavy bodies do in ours [Footnote 15: This passage would certainly seem to establish Leonardo's claim to be regarded as the original discoverer of the cause of the ashy colour of the new moon (*lumen cinereum*). His observations however, having hitherto remained unknown to astronomers, Moestlin and Kepler have been credited with the discoveries which they made independently a century later.]

Some disconnected notes treat of the same subject in MS. C. A. 239b; 718b and 719b; "*Perche la luna cinta della parte alluminata dal sole in ponente, tra maggior splendore in mezzo a tal cerchio, che quando essa eclissava il sole. Questo accade perche nell' eclissare il sole ella ombrava il nostro oceano, il qual caso non accade essendo in ponente, quando il sole alluma esso oceano.*" The editors of the "*Saggio*" who first published this passage (page 12) add another short one about the seasons in the moon which I confess not to have seen in the original manuscript: "*La luna ha ogni mese un verno e una state, e ha maggiori freddi e maggiori caldi, e i suoi equinozii son piu freddi de' nostri.*"]

When the eye is in the East and sees the moon in the West near to the setting sun, it sees it with its shaded portion surrounded by luminous portions; and the lateral and upper portion of this light is derived from the sun, and the lower portion from the ocean in the West, which receives the solar rays and reflects

them on the lower waters of the moon, and indeed affords the part of the moon that is in shadow as much radiance as the moon gives the earth at midnight. Therefore it is not totally dark, and hence some have believed that the moon must in parts have a light of its own besides that which is given it by the sun; and this light is due, as has been said, to the above-mentioned cause, — that our seas are illuminated by the sun.

Again, it might be said that the circle of radiance shown by the moon when it and the sun are both in the West is wholly borrowed from the sun, when it, and the sun, and the eye are situated as is shown above.

[Footnote 23. 24: The larger of the two diagrams reproduced above stands between these two lines, and the smaller one is sketched in the margin. At the spot marked *A* Leonardo wrote *corpo solare* (solar body) in the larger diagram and *Sole* (sun) in the smaller one. At *C luna* (moon) is written and at *B terra* (the earth).]

Some might say that the air surrounding the moon as an element, catches the light of the sun as our atmosphere does, and that it is this which completes the luminous circle on the body of the moon.

Some have thought that the moon has a light of its own, but this opinion is false, because they have founded it on that dim light seen between the horns of the new moon, which looks dark where it is close to the bright part, while against the darkness of the background it looks so light that many have taken it to be a ring of new radiance completing the circle where the tips of the horns illuminated by the sun cease to shine [Footnote 34: See Pl. CVIII, No. 5.]. And this difference of background arises from the fact that the portion of that background which is conterminous with the bright part of the moon, by comparison with that brightness looks darker than it is; while at the upper part, where a portion of the luminous circle is to be seen of uniform width, the result is that the moon, being brighter there than the medium or background on which it is seen by comparison with that darkness it looks more luminous at that edge than it is. And that brightness at such a time itself is derived from our ocean and other inland-seas. These are, at that time, illuminated by the sun which is already setting in such a way as that the sea then fulfils the same function to the dark side of the moon as the moon at its fifteenth day does to us when the sun is set. And the small amount of light which the dark side of the moon receives bears the same proportion to the light of that side which is illuminated, as that... [Footnote 42: Here the text breaks off; lines 43-52 are written on the margin.].

If you want to see how much brighter the shaded portion of the moon is than the background on which it is seen, conceal the luminous portion of the moon with your hand or with some other more distant object.

On the spots in the moon (903-907).

903.

THE SPOTS ON THE MOON.

Some have said that vapours rise from the moon, after the manner of clouds and are interposed between the moon and our eyes. But, if this were the case, these spots would never be permanent, either as to position or form; and, seeing the moon from various aspects, even if these spots did not move they would change in form, as objects do which are seen from different sides.

904.

OF THE SPOTS ON THE MOON.

Others say that the moon is composed of more or less transparent parts; as though one part were something like alabaster and others like crystal or glass. It would follow from this that the sun casting its rays on the less transparent portions, the light would remain on the surface, and so the denser part would be illuminated, and the transparent portions would display the shadow of their darker depths; and this is their account of the structure and nature of the moon. And this opinion has found favour with many philosophers, and particularly with Aristotle, and yet it is a false view — for, in the various phases and frequent changes of the moon and sun to our eyes, we should see these spots vary, at one time looking dark and at another light: they would be dark when the sun is in the West and the moon in the middle of the sky; for then the transparent hollows would be in shadow as far as the tops of the edges of those transparent hollows, because the sun could not then fling his rays into the mouth of the hollows, which however, at full moon, would be seen in bright light, at which time the moon is in the East and faces the sun in the West; then the sun would illuminate even the lowest depths of these transparent places and thus, as there would be no shadows cast, the moon at these times would not show us the spots in question;

and so it would be, now more and now less, according to the changes in the position of the sun to the moon, and of the moon to our eyes, as I have said above.

905.

OF THE SPOTS ON THE MOON.

It has been asserted, that the spots on the moon result from the moon being of varying thinness or density; but if this were so, when there is an eclipse of the moon the solar rays would pierce through the portions which were thin as is alleged [Footnote 3-5: *Eclissi*. This word, as it seems to me, here means eclipses of the sun; and the sense of the passage, as I understand it, is that by the foregoing hypothesis the moon, when it comes between the sun and the earth must appear as if pierced, — we may say like a sieve.]. But as we do not see this effect the opinion must be false.

Others say that the surface of the moon is smooth and polished and that, like a mirror, it reflects in itself the image of our earth. This view is also false, inasmuch as the land, where it is not covered with water, presents various aspects and forms. Hence when the moon is in the East it would reflect different spots from those it would show when it is above us or in the West; now the spots on the moon, as they are seen at full moon, never vary in the course of its motion over our hemisphere. A second reason is that an object reflected in a convex body takes up but a small portion of that body, as is proved in perspective [Footnote 18: *come e provato*. This alludes to the accompanying diagram.]. The third reason is that when the moon is full, it only faces half the hemisphere of the illuminated earth, on which only the ocean and other waters reflect bright light, while the land makes spots on that brightness; thus half of our earth would be seen girt round with the brightness of the sea lighted up by the sun, and in the moon this reflection would be the smallest part of that moon. Fourthly, a radiant body cannot be reflected from another equally radiant; therefore the sea, since it borrows its brightness from the sun, — as the moon does — , could not cause the earth to be reflected in it, nor indeed could the body of the sun be seen reflected in it, nor indeed any star opposite to it.

906.

If you keep the details of the spots of the moon under observation you will often find great variation in them, and this I myself have proved by drawing them. And this is caused by the clouds that rise from the waters in the moon, which come between the sun and those waters, and by their shadow deprive these waters of the sun's rays. Thus those waters remain dark, not being able to reflect the solar body.

907.

How the spots on the moon must have varied from what they formerly were, by reason of the course of its waters.

On the moon's halo.

908.

OF HALOS ROUND THE MOON.

I have found, that the circles which at night seem to surround the moon, of various sizes, and degrees of density are caused by various gradations in the densities of the vapours which exist at different altitudes between the moon and our eyes. And of these halos the largest and least red is caused by the lowest of these vapours; the second, smaller one, is higher up, and looks redder because it is seen through two vapours. And so on, as they are higher they will appear smaller and redder, because, between the eye and them, there is thicker vapour. Whence it is proved that where they are seen to be reddest, the vapours are most dense.

On instruments for observing the moon (909. 910).

909.

If you want to prove why the moon appears larger than it is, when it reaches

the horizon; take a lens which is highly convex on one surface and concave on the opposite, and place the concave side next the eye, and look at the object beyond the convex surface; by this means you will have produced an exact imitation of the atmosphere included beneath the sphere of fire and outside that of water; for this atmosphere is concave on the side next the earth, and convex towards the fire.

910.

Construct glasses to see the moon magnified.

[Footnote: See the Introduction, p. 136, Fracastoro says in his work Homocentres: "*Per dua specilla ocularia si quis perspiciat, alteri altero superposito, majora multo et propinquiora videbit omnia. — Quin imo quaedam specilla ocularia fiunt tantae densitatis, ut si per ea quis aut lunam, aut aliud siderum spectet, adeo propinqua illa iudicet, ut ne turres ipsas excedant*" (sect. II c. 8 and sect. III, c. 23).]

I. THE STARS. On the light of the stars (911-913). 911. The stars are visible by night and not by day, because we are eneeath the dense atmosphere, which is full of innumerable articles of moisture, each of which independently, when the ays of the sun fall upon it, reflects a radiance, and so these umberless bright particles conceal the stars; and if it were not or this atmosphere the sky would always display the stars against ts darkness. [Footnote: See No. 296, which also refers to starlight.] 912. Whether the stars have their light from the sun or in themselves. Some say that they shine of themselves, alledging that if Venus nd Mercury had not a light of their own, when they come between ur eye and the sun they would darken so much of the sun as they ould cover from our eye. But this is false, for it is proved that dark object against a luminous body is enveloped and entirely onceaied by the lateral rays of the rest of that luminous body nd so remains invisible. As may be seen when the sun is seen hrough the boughs of trees bare of their leaves, at some distance he branches do not conceal any portion of the sun from our eye. he same thing happens with the above mentioned planets which, hough they have no light of their own, do not — as has been said — onceaial any part of the sun from our eye .

SECOND ARGUMENT.

Some say that the stars appear most brilliant at night in proportion as they are

higher up; and that if they had no light of their own, the shadow of the earth which comes between them and the sun, would darken them, since they would not face nor be faced by the solar body. But those persons have not considered that the conical shadow of the earth cannot reach many of the stars; and even as to those it does reach, the cone is so much diminished that it covers very little of the star's mass, and all the rest is illuminated by the sun.

Footnote: From this and other remarks (see No. 902) it is clear hat Leonardo was familiar with the phenomena of Irradiation.]

13.

Why the planets appear larger in the East than they do overhead, whereas the contrary should be the case, as they are 3500 miles nearer to us when in mid sky than when on the horizon.

All the degrees of the elements, through which the images of the celestial bodies pass to reach the eye, are equal curves and the angles by which the central line of those images passes through them, are unequal angles [Footnote 13: *inequali*, here and elsewhere does not mean unequal in the sense of not being equal to each other, but angles which are not right angles.]; and the distance is greater, as is shown by the excess of *a b* beyond *a d*; and the enlargement of these celestial bodies on the horizon is shown by the 9th of the 7th.

Observations on the stars.

914.

To see the real nature of the planets open the covering and note at the base [Footnote 4: *basa*. This probably alludes to some instrument, perhaps the Camera obscura.] one single planet, and the reflected movement of this base will show the nature of the said planet; but arrange that the base may face only one at the time.

On history of astronomy.

915.

Cicero says in [his book] De Divinatione that Astrology has been practised five hundred seventy thousand years before the Trojan war.

57000.

[Footnote: The statement that CICERO, *De Divin.* ascribes the discovery of astrology to a period 57000 years before the Trojan war I believe to be quite erroneous. According to ERNESTI, *Clavis Ciceroniana*, CH. G. SCHULZ (*Lexic. Cicer.*) and the edition of *De Divin.* by GIESE the word Astrologia occurs only twice in CICERO: *De Divin. II*, 42. *Ad Chaldaeorum monstra veniamus, de quibus Eudoxus, Platonis auditor, in astrologia judicio doctissimorum hominum facile princeps, sic opinatur (id quod scriptum reliquit): Chaldaeis in praedictione et in notatione cujusque vitae ex natali die minime esse credendum.*” He then quotes the condemnatory verdict of other philosophers as to the teaching of the Chaldaeans but says nothing as to the antiquity and origin of astronomy. CICERO further notes *De oratore I*, 16 that Aratus was “*ignarus astrologiae*” but that is all. So far as I know the word occurs nowhere else in CICERO; and the word *Astronomia* he does not seem to have used at all. (H. MULLER-STRUBING.)]

Of time and its divisions (916-918).

916.

Although time is included in the class of Continuous Quantities, being indivisible and immaterial, it does not come entirely under the head of Geometry, which represents its divisions by means of figures and bodies of infinite variety, such as are seen to be continuous in their visible and material properties. But only with its first principles does it agree, that is with the Point and the Line; the point may be compared to an instant of time, and the line may be likened to the length of a certain quantity of time, and just as a line begins and terminates in a point, so such a space of time. begins and terminates in an instant. And whereas a line is infinitely divisible, the divisibility of a space of time is of the same nature; and as the divisions of the line may bear a certain proportion to each other, so may the divisions of time.

[Footnote: This passage is repeated word for word on page 190b of the same manuscript and this is accounted for by the text in Vol. I, No. 4. Compare also No. 1216.]

917.

Describe the nature of Time as distinguished from the Geometrical definitions.

918.

Divide an hour into 3000 parts, and this you can do with a clock by making the pendulum lighter or heavier.

XVI. PHYSICAL GEOGRAPHY.

Leonardo's researches as to the structure of the earth and sea were made at a time, when the extended voyages of the Spaniards and Portuguese had also excited a special interest in geographical questions in Italy, and particularly in Tuscany. Still, it need scarcely surprise us to find that in deeper questions, as to the structure of the globe, the primitive state of the earth's surface, and the like, he was far in advance of his time.

The number of passages which treat of such matters is relatively considerable; like almost all Leonardo's scientific notes they deal partly with theoretical and partly with practical questions. Some of his theoretical views of the motion of water were collected in a copied manuscript volume by an early transcriber, but without any acknowledgment of the source whence they were derived. This copy is now in the Library of the Barberini palace at Rome and was published under the title: "De moto e misura dell'acqua," by FRANCESCO CARDINALI, Bologna 1828. *In this work the texts are arranged under the following titles:* Libr. I. Della spera dell'acqua; Libr. II. Del moto dell'acqua; Libr. III. Dell'onda dell'acqua; Libr. IV. Dei retrosi d'acqua; Libr. V. Dell'acqua cadente; Libr. VI. Delle rotture fatte dall'acqua; Libr. VII Delle cose portate dall'acqua; Libr. VIII. Dell'oncia dell'acqua e delle canne; Libr. IX. De molini e d'altri ordigni d'acqua.

The large number of isolated observations scattered through the manuscripts, accounts for our so frequently finding notes of new schemes for the arrangement of those relating to water and its motions, particularly in the Codex Atlanticus: I have printed several of these plans as an introduction to the Physical Geography, and I have actually arranged the texts in accordance with the clue afforded by one of them which is undoubtedly one of the latest notes referring to the subject (No. 920). The text given as No. 930 which is also taken from a late note-book of Leonardo's, served as a basis for the arrangement of the first of the seven books — or sections — , bearing the title: Of the Nature of Water (Dell'acque in se).

As I have not made it any part of this undertaking to print the passages which refer to purely physical principles, it has also been necessary to exclude those practical researches which, in accordance with indications given in 920, ought to come in as Books 13, 14 and 15. I can only incidentally mention here that

Leonardo — as it seems to me, especially in his youth — devoted a great deal of attention to the construction of mills. This is proved by a number of drawings of very careful and minute execution, which are to be found in the Codex Atlanticus. Nor was it possible to include his considerations on the regulation of rivers, the making of canals and so forth (No. 920, Books 10, 11 and 12); but those passages in which the structure of a canal is directly connected with notices of particular places will be found duly inserted under section XVII (Topographical notes). In Vol. I, No. 5 the text refers to canal-making in general.

On one point only can the collection of passages included under the general heading of Physical Geography claim to be complete. When comparing and sorting the materials for this work I took particular care not to exclude or omit any text in which a geographical name was mentioned even incidentally, since in all such researches the chief interest, as it appeared to me, attached to the question whether these acute observations on the various local characteristics of mountains, rivers or seas, had been made by Leonardo himself, and on the spot. It is self-evident that the few general and somewhat superficial observations on the Rhine and the Danube, on England and Flanders, must have been obtained from maps or from some informants, and in the case of Flanders Leonardo himself acknowledges this (see No. 1008). But that most of the other and more exact observations were made, on the spot, by Leonardo himself, may be safely assumed from their method and the style in which he writes of them; and we should bear it in mind that in all investigations, of whatever kind, experience is always spoken of as the only basis on which he relies. Incidentally, as in No. 984, he thinks it necessary to allude to the total absence of all recorded observations.

I.

INTRODUCTION.

Schemes for the arrangement of the materials (919-928).

919.

These books contain in the beginning: Of the nature of water itself in its motions; the others treat of the effects of its currents, which change the world in

its centre and its shape.

920.

DIVISIONS OF THE BOOK.

Book 1 of water in itself.

Book 2 of the sea.

Book 3 of subterranean rivers.

Book 4 of rivers.

Book 5 of the nature of the abyss.

Book 6 of the obstacles.

Book 7 of gravels.

Book 8 of the surface of water.

Book 9 of the things placed therein.

Book 10 of the repairing of rivers.

Book 11 of conduits.

Book 12 of canals.

Book 13 of machines turned by water.

Book 14 of raising water.

Book 15 of matters worn away by water.

921.

First you shall make a book treating of places occupied by fresh waters, and the second by salt waters, and the third, how by the disappearance of these, our parts of the world were made lighter and in consequence more remote from the centre of the world.

922.

First write of all water, in each of its motions; then describe all its bottoms and their various materials, always referring to the propositions concerning the said waters; and let the order be good, for otherwise the work will be confused.

Describe all the forms taken by water from its greatest to its smallest wave, and their causes.

923.

Book 9, of accidental risings of water.

924.

THE ORDER OF THE BOOK.

Place at the beginning what a river can effect.

925.

A book of driving back armies by the force of a flood made by releasing waters.

A book showing how the waters safely bring down timber cut in the mountains.

A book of boats driven against the impetus of rivers.

A book of raising large bridges higher. Simply by the swelling of the waters.

A book of guarding against the impetus of rivers so that towns may not be damaged by them.

926.

A book of the ordering of rivers so as to preserve their banks.

A book of the mountains, which would stand forth and become land, if our hemisphere were to be uncovered by the water.

A book of the earth carried down by the waters to fill up the great abyss of the seas.

A book of the ways in which a tempest may of itself clear out filled up sea-ports.

A book of the shores of rivers and of their permanency.

A book of how to deal with rivers, so that they may keep their bottom scoured by their own flow near the cities they pass.

A book of how to make or to repair the foundations for bridges over the rivers.

A book of the repairs which ought to be made in walls and banks of rivers where the water strikes them.

A book of the formation of hills of sand or gravel at great depths in water.

927.

Water gives the first impetus to its motion.

A book of the levelling of waters by various means,

A book of diverting rivers from places where they do mischief.

A book of guiding rivers which occupy too much ground.

A book of parting rivers into several branches and making them fordable.

A book of the waters which with various currents pass through seas.

A book of deepening the beds of rivers by means of currents of water.

A book of controlling rivers so that the little beginnings of mischief, caused by them, may not increase.

A book of the various movements of waters passing through channels of different forms.

A book of preventing small rivers from diverting the larger one into which their waters run.

A book of the lowest level which can be found in the current of the surface of rivers.

A book of the origin of rivers which flow from the high tops of mountains.

A book of the various motions of waters in their rivers.

928.

Of inequality in the concavity of a ship. [Footnote 1: The first line of this passage was added subsequently, evidently as a correction of the following line.]

A book of the inequality in the curve of the sides of ships.

A book of the inequality in the position of the tiller.

A book of the inequality in the keel of ships.

A book of various forms of apertures by which water flows out.

A book of water contained in vessels with air, and of its movements.

A book of the motion of water through a syphon. [Footnote 7: *cicognole*, see No. 966, 11, 17.]

A book of the meetings and union of waters coming from different directions.

A book of the various forms of the banks through which rivers pass.

A book of the various forms of shoals formed under the sluices of rivers.

A book of the windings and meanderings of the currents of rivers.

A book of the various places whence the waters of rivers are derived.

A book of the configuration of the shores of rivers and of their permanency.

A book of the perpendicular fall of water on various objects.

A book of the course of water when it is impeded in various places.

A book of the various forms of the obstacles which impede the course of waters.

A book of the concavity and globosity formed round various objects at the bottom.

A book of conducting navigable canals above or beneath the rivers which intersect them.

A book of the soils which absorb water in canals and of repairing them.

A book of creating currents for rivers, which quit their beds, [and] for rivers choked with soil.

General introduction.

929.

THE BEGINNING OF THE TREATISE ON WATER.

By the ancients man has been called the world in miniature; and certainly this name is well bestowed, because, inasmuch as man is composed of earth, water, air and fire, his body resembles that of the earth; and as man has in him bones the supports and framework of his flesh, the world has its rocks the supports of the earth; as man has in him a pool of blood in which the lungs rise and fall in breathing, so the body of the earth has its ocean tide which likewise rises and falls every six hours, as if the world breathed; as in that pool of blood veins have their origin, which ramify all over the human body, so likewise the ocean sea fills the body of the earth with infinite springs of water. The body of the earth lacks sinews and this is, because the sinews are made expressly for movements and, the world being perpetually stable, no movement takes place, and no movement taking place, muscles are not necessary. — But in all other points they are much alike.

I.

OF THE NATURE OF WATER.

The arrangement of Book I.

930.

THE ORDER OF THE FIRST BOOK ON WATER.

Define first what is meant by height and depth; also how the elements are situated one inside another. Then, what is meant by solid weight and by liquid weight; but first what weight and lightness are in themselves. Then describe why water moves, and why its motion ceases; then why it becomes slower or more rapid; besides this, how it always falls, being in contact with the air but lower than the air. And how water rises in the air by means of the heat of the sun, and then falls again in rain; again, why water springs forth from the tops of mountains; and if the water of any spring higher than the ocean can pour forth water higher than the surface of that ocean. And how all the water that returns to the ocean is higher than the sphere of waters. And how the waters of the equatorial seas are higher than the waters of the North, and higher beneath the body of the sun than in any part of the equatorial circle; for experiment shows that under the heat of a burning brand the water near the brand boils, and the water surrounding this ebullition always sinks with a circular eddy. And how the waters of the North are lower than the other seas, and more so as they become colder, until they are converted into ice.

Definitions (931. 932).

931.

OF WHAT IS WATER.

Among the four elements water is the second both in weight and in instability.

932.

THE BEGINNING OF THE BOOK ON WATER.

Sea is the name given to that water which is wide and deep, in which the waters have not much motion.

[Footnote: Only the beginning of this passage is here given, the remainder consists of definitions which have no direct bearing on the subject.]

Of the surface of the water in relation to the globe (933-936).

933.

The centres of the sphere of water are two, one universal and common to all water, the other particular. The universal one is that which is common to all waters not in motion, which exist in great quantities. As canals, ditches, ponds, fountains, wells, dead rivers, lakes, stagnant pools and seas, which, although they are at various levels, have each in itself the limits of their superficies equally distant from the centre of the earth, such as lakes placed at the tops of high mountains; as the lake near Pietra Pana and the lake of the Sybil near Norcia; and all the lakes that give rise to great rivers, as the Ticino from Lago Maggiore, the Adda from the lake of Como, the Mincio from the lake of Garda, the Rhine from the lakes of Constance and of Chur, and from the lake of Lucerne, like the Tigris which passes through Asia Minor carrying with it the waters of three lakes, one above the other at different heights of which the highest is Munace, the middle one Pallas, and the lowest Triton; the Nile again flows from three very high lakes in Ethiopia.

[Footnote 5: *Pietra Pana*, a mountain near Florence. If for Norcia, we may read Norchia, the remains of the Etruscan city near Viterbo, there can be no doubt that by '*Lago della Sibilla*' — a name not known elsewhere, so far as I can learn — Leonardo meant *Lago di Vico* (Lacus Ciminus, Aen. 7).]

934.

OF THE CENTRE OF THE OCEAN.

The centre of the sphere of waters is the true centre of the globe of our world, which is composed of water and earth, having the shape of a sphere. But, if you

want to find the centre of the element of the earth, this is placed at a point equidistant from the surface of the ocean, and not equidistant from the surface of the earth; for it is evident that this globe of earth has nowhere any perfect rotundity, excepting in places where the sea is, or marshes or other still waters. And every part of the earth that rises above the water is farther from the centre.

935.

OF THE SEA WHICH CHANGES THE WEIGHT OF THE EARTH.

The shells, oysters, and other similar animals, which originate in sea-mud, bear witness to the changes of the earth round the centre of our elements. This is proved thus: Great rivers always run turbid, being coloured by the earth, which is stirred by the friction of their waters at the bottom and on their shores; and this wearing disturbs the face of the strata made by the layers of shells, which lie on the surface of the marine mud, and which were produced there when the salt waters covered them; and these strata were covered over again from time to time, with mud of various thickness, or carried down to the sea by the rivers and floods of more or less extent; and thus these layers of mud became raised to such a height, that they came up from the bottom to the air. At the present time these bottoms are so high that they form hills or high mountains, and the rivers, which wear away the sides of these mountains, uncover the strata of these shells, and thus the softened side of the earth continually rises and the antipodes sink closer to the centre of the earth, and the ancient bottoms of the seas have become mountain ridges.

936.

Let the earth make whatever changes it may in its weight, the surface of the sphere of waters can never vary in its equal distance from the centre of the world.

Of the proportion of the mass of water to that of the earth (937. 938).

937.

WHETHER THE EARTH IS LESS THAN THE WATER.

Some assert that it is true that the earth, which is not covered by water is much less than that covered by water. But considering the size of 7000 miles in diameter which is that of this earth, we may conclude the water to be of small depth.

938.

OF THE EARTH.

The great elevations of the peaks of the mountains above the sphere of the water may have resulted from this that: a very large portion of the earth which was filled with water that is to say the vast cavern inside the earth may have fallen in a vast part of its vault towards the centre of the earth, being pierced by means of the course of the springs which continually wear away the place where they pass.

Sinking in of countries like the Dead Sea in Syria, that is Sodom and Gomorrah.

It is of necessity that there should be more water than land, and the visible portion of the sea does not show this; so that there must be a great deal of water inside the earth, besides that which rises into the lower air and which flows through rivers and springs.

[Footnote: The small sketch below on the left, is placed in the original close to the text referring to the Dead Sea.]

The theory of Plato.

939.

THE FIGURES OF THE ELEMENTS.

Of the figures of the elements; and first as against those who deny the opinions

of Plato, and who say that if the elements include one another in the forms attributed to them by Plato they would cause a vacuum one within the other. I say it is not true, and I here prove it, but first I desire to propound some conclusions. It is not necessary that the elements which include each other should be of corresponding magnitude in all the parts, of that which includes and of that which is included. We see that the sphere of the waters varies conspicuously in mass from the surface to the bottom, and that, far from investing the earth when that was in the form of a cube that is of 8 angles as Plato will have it, that it invests the earth which has innumerable angles of rock covered by the water and various prominences and concavities, and yet no vacuum is generated between the earth and water; again, the air invests the sphere of waters together with the mountains and valleys, which rise above that sphere, and no vacuum remains between the earth and the air, so that any one who says a vacuum is generated, speaks foolishly.

But to Plato I would reply that the surface of the figures which according to him the elements would have, could not exist.

That the flow of rivers proves the slope of the land.

940.

PROVES HOW THE EARTH IS NOT GLOBULAR AND NOT BEING GLOBULAR CANNOT HAVE A COMMON CENTRE.

We see the Nile come from Southern regions and traverse various provinces, running towards the North for a distance of 3000 miles and flow into the Mediterranean by the shores of Egypt; and if we will give to this a fall of ten braccia a mile, as is usually allowed to the course of rivers in general, we shall find that the Nile must have its mouth ten miles lower than its source. Again, we see the Rhine, the Rhone and the Danube starting from the German parts, almost the centre of Europe, and having a course one to the East, the other to the North, and the last to Southern seas. And if you consider all this you will see that the plains of Europe in their aggregate are much higher than the high peaks of the maritime mountains; think then how much their tops must be above the sea

shores.

Theory of the elevation of water within the mountains.

941.

OF THE HEAT THAT IS IN THE WORLD.

Where there is life there is heat, and where vital heat is, there is movement of vapour. This is proved, inasmuch as we see that the element of fire by its heat always draws to itself damp vapours and thick mists as opaque clouds, which it raises from seas as well as lakes and rivers and damp valleys; and these being drawn by degrees as far as the cold region, the first portion stops, because heat and moisture cannot exist with cold and dryness; and where the first portion stops the rest settle, and thus one portion after another being added, thick and dark clouds are formed. They are often wafted about and borne by the winds from one region to another, where by their density they become so heavy that they fall in thick rain; and if the heat of the sun is added to the power of the element of fire, the clouds are drawn up higher still and find a greater degree of cold, in which they form ice and fall in storms of hail. Now the same heat which holds up so great a weight of water as is seen to rain from the clouds, draws them from below upwards, from the foot of the mountains, and leads and holds them within the summits of the mountains, and these, finding some fissure, issue continuously and cause rivers.

The relative height of the surface of the sea to that of the land (942-945).

942.

OF THE SEA, WHICH TO MANY FOOLS APPEARS TO BE HIGHER THAN THE EARTH WHICH FORMS ITS SHORE.

b d is a plain through which a river flows to the sea; this plain ends at the sea,

and since in fact the dry land that is uncovered is not perfectly level — for, if it were, the river would have no motion — as the river does move, this place is a slope rather than a plain; hence this plain *d b* so ends where the sphere of water begins that if it were extended in a continuous line to *b a* it would go down beneath the sea, whence it follows that the sea *a c b* looks higher than the dry land.

Obviously no portions of dry land left uncovered by water can ever be lower than the surface of the watery sphere.

943.

**OF CERTAIN PERSONS WHO SAY THE WATERS WERE HIGHER
THAN THE DRY LAND.**

Certainly I wonder not a little at the common opinion which is contrary to truth, but held by the universal consent of the judgment of men. And this is that all are agreed that the surface of the sea is higher than the highest peaks of the mountains; and they allege many vain and childish reasons, against which I will allege only one simple and short reason; We see plainly that if we could remove the shores of the sea, it would invest the whole earth and make it a perfect sphere. Now, consider how much earth would be carried away to enable the waves of the sea to cover the world; therefore that which would be carried away must be higher than the sea-shore.

944.

**THE OPINION OF SOME PERSONS WHO SAY
THAT THE WATER OF SOME SEAS IS HIGHER
THAN THE HIGHEST SUMMITS OF
MOUNTAINS; AND NEVERTHELESS THE
WATER WAS FORCED UP TO THESE SUMMITS.**

Water would not move from place to place if it were not that it seeks the lowest level and by a natural consequence it never can return to a height like that of the place where it first on issuing from the mountain came to light. And that portion of the sea which, in your vain imagining, you say was so high that it flowed over the summits of the high mountains, for so many centuries would be swallowed up and poured out again through the issue from these mountains. You can well imagine that all the time that Tigris and Euphrates

945.

have flowed from the summits of the mountains of Armenia, it must be believed that all the water of the ocean has passed very many times through these mouths. And do you not believe that the Nile must have sent more water into the sea than at present exists of all the element of water? Undoubtedly, yes. And if all this water had fallen away from this body of the earth, this terrestrial machine would long since have been without water. Whence we may conclude that the water goes from the rivers to the sea, and from the sea to the rivers, thus constantly circulating and returning, and that all the sea and the rivers have passed through the mouth of the Nile an infinite number of times [Footnote: *Moti Armeni, Ermini* in the original, in M. RAVAISSON'S transcript "*monti ernini [le loro ruine?]*". He renders this "Le Tigre et l'Euphrate se sont deverses par les sommets des montagnes [avec leurs eaux destructives?] on pent cro're" &c. Leonardo always writes *Ermini, Erminia*, for *Armeni, Armenia* (Arabic: *Irminiah*). M. RAVAISSON also deviates from the original in his translation of the following passage: "*Or tu ne crois pas que le Nil ait mis plus d'eau dans la mer qu'il n'y en a a present dans tout l'element de l'eau. Il est certain que si cette eau etait tombee*" &c.]

II.

ON THE OCEAN.

Refutation of Pliny's theory as to the saltness of the sea (946. 947).

946.

WHY WATER IS SALT.

Pliny says in his second book, chapter 103, that the water of the sea is salt because the heat of the sun dries up the moisture and drinks it up; and this gives to the wide stretching sea the savour of salt. But this cannot be admitted, because if the saltness of the sea were caused by the heat of the sun, there can be no doubt that lakes, pools and marshes would be so much the more salt, as their waters have less motion and are of less depth; but experience shows us, on the contrary, that these lakes have their waters quite free from salt. Again it is stated by Pliny in the same chapter that this saltness might originate, because all the sweet and subtle portions which the heat attracts easily being taken away, the more bitter and coarser part will remain, and thus the water on the surface is fresher than at the bottom [Footnote 22: Compare No. 948.]; but this is contradicted by the same reason given above, which is, that the same thing would happen in marshes and other waters, which are dried up by the heat. Again, it has been said that the saltness of the sea is the sweat of the earth; to this it may be answered that all the springs of water which penetrate through the earth, would then be salt. But the conclusion is, that the saltness of the sea must proceed from the many springs of water which, as they penetrate into the earth, find mines of salt and these they dissolve in part, and carry with them to the ocean and the other seas, whence the clouds, the begetters of rivers, never carry it up. And the sea would be saltier in our times than ever it was at any time; and if the adversary were to say that in infinite time the sea would dry up or congeal into salt, to this I answer that this salt is restored to the earth by the setting free of that part of the earth which rises out of the sea with the salt it has acquired, and the rivers return it to the earth under the sea.

[Footnote: See PLINY, Hist. Nat. II, CIII [C]. *Itaque Solis ardore siccatur liquor: et hoc esse masculum sidus accepimus, torrens cuncta sorbensque.* (cp. CIV.) *Sic mari late patenti saporem incoqui salis, aut quia exhausto inde dulci tenuique, quod facillime trahat vis ignea, omne asperius crassiusque linquatur: ideo summa aequorum aqua dulciorem profundam; hanc esse veriore causam, quam quod mare terrae sudor sit aeternus: aut quia plurimum ex arido misceatur illi vapore: aut quia terrae natura sicut medicatas aquas inficiat ...* (cp. CV): *altissimum mare XV. stadiorum Fabianus tradit. Alii n Ponto coadverso Coraxorum gentis (vocant B Ponti) trecentis fere a continenti stadiis immensam altitudinem maris tradunt, vadis nunquam repertis.* (cp. CVI [CIII]) *Mirabilius id faciunt aquae dulces, juxta mare, ut fistulis emicantes. Nam nec*

aquarum natura a miraculis cessat. Dulces mari invehuntur, leviores haud dubie. Ideo et marinae, quarum natura gravior, magis invecta sustinent. Quaedam vero et dulces inter se supermeant alias.]

947.

For the third and last reason we will say that salt is in all created things; and this we learn from water passed over the ashes and cinders of burnt things; and the urine of every animal, and the superfluities issuing from their bodies, and the earth into which all things are converted by corruption.

But, — to put it better, — given that the world is everlasting, it must be admitted that its population will also be eternal; hence the human species has eternally been and would be consumers of salt; and if all the mass of the earth were to be turned into salt, it would not suffice for all human food [Footnote 27: That is, on the supposition that salt, once consumed, disappears for ever.]; whence we are forced to admit, either that the species of salt must be everlasting like the world, or that it dies and is born again like the men who devour it. But as experience teaches us that it does not die, as is evident by fire, which does not consume it, and by water which becomes salt in proportion to the quantity dissolved in it, — and when it is evaporated the salt always remains in the original quantity — it must pass through the bodies of men either in the urine or the sweat or other excretions where it is found again; and as much salt is thus got rid of as is carried every year into towns; therefore salt is dug in places where there is urine. — Sea hogs and sea winds are salt.

We will say that the rains which penetrate the earth are what is under the foundations of cities with their inhabitants, and are what restore through the internal passages of the earth the saltiness taken from the sea; and that the change in the place of the sea, which has been over all the mountains, caused it to be left there in the mines found in those mountains, &c.

The characteristics of sea water (948. 949).

948.

The waters of the salt sea are fresh at the greatest depths.

949.

THAT THE OCEAN DOES NOT PENETRATE UNDER THE EARTH.

The ocean does not penetrate under the earth, and this we learn from the many and various springs of fresh water which, in many parts of the ocean make their way up from the bottom to the surface. The same thing is farther proved by wells dug beyond the distance of a mile from the said ocean, which fill with fresh water; and this happens because the fresh water is lighter than salt water and consequently more penetrating.

Which weighs most, water when frozen or when not frozen?

FRESH WATER PENETRATES MORE AGAINST SALT WATER THAN SALT WATER AGAINST FRESH WATER.

That fresh water penetrates more against salt water, than salt water against fresh is proved by a thin cloth dry and old, hanging with the two opposite ends equally low in the two different waters, the surfaces of which are at an equal level; and it will then be seen how much higher the fresh water will rise in this piece of linen than the salt; by so much is the fresh lighter than the salt.

On the formation of Gulfs (950. 951).

950.

All inland seas and the gulfs of those seas, are made by rivers which flow into the sea.

951.

HERE THE REASON IS GIVEN OF THE EFFECTS PRODUCED BY THE WATERS IN THE ABOVE MENTIONED PLACE.

All the lakes and all the gulfs of the sea and all inland seas are due to rivers which distribute their waters into them, and from impediments in their downfall

into the Mediterranean — which divides Africa from Europe and Europe from Asia by means of the Nile and the Don which pour their waters into it. It is asked what impediment is great enough to stop the course of the waters which do not reach the ocean.

On the encroachments of the sea on the land and vice versa (952-954).

952.

OF WAVES.

A wave of the sea always breaks in front of its base, and that portion of the crest will then be lowest which before was highest.

[Footnote: The page of FRANCESCO DI GIORGIO'S *Trattato*, on which Leonardo has written this remark, contains some notes on the construction of dams, harbours &c.]

953.

That the shores of the sea constantly acquire more soil towards the middle of the sea; that the rocks and promontories of the sea are constantly being ruined and worn away; that the Mediterranean seas will in time discover their bottom to the air, and all that will be left will be the channel of the greatest river that enters it; and this will run to the ocean and pour its waters into that with those of all the rivers that are its tributaries.

954.

How the river Po, in a short time might dry up the Adriatic sea in the same way as it has dried up a large part of Lombardy.

The ebb and flow of the tide (955-960).

955.

Where there is a larger quantity of water, there is a greater flow and ebb, but the contrary in narrow waters.

Look whether the sea is at its greatest flow when the moon is half way over our hemisphere [on the meridian].

956.

Whether the flow and ebb are caused by the moon or the sun, or are the breathing of this terrestrial machine. That the flow and ebb are different in different countries and seas.

[Footnote: 1. Allusion may here be made to the mythological explanation of the ebb and flow given in the Edda. Utgardloki says to Thor (Gylfaginning 48): "When thou wert drinking out of the horn, and it seemed to thee that it was slow in emptying a wonder befell, which I should not have believed possible: the other end of the horn lay in the sea, which thou sawest not; but when thou shalt go to the sea, thou shalt see how much thou hast drunk out of it. And that men now call the ebb tide."

Several passages in various manuscripts treat of the ebb and flow. In collecting them I have been guided by the rule only to transcribe those which named some particular spot.]

957.

Book 9 of the meeting of rivers and their flow and ebb. The cause is the same in the sea, where it is caused by the straits of Gibraltar. And again it is caused by whirlpools.

958.

OF THE FLOW AND EBB.

All seas have their flow and ebb in the same period, but they seem to vary because the days do not begin at the same time throughout the universe; in such wise as that when it is midday in our hemisphere, it is midnight in the opposite hemisphere; and at the Eastern boundary of the two hemispheres the night begins which follows on the day, and at the Western boundary of these hemispheres begins the day, which follows the night from the opposite side. Hence it is to be inferred that the above mentioned swelling and diminution in the height of the seas, although they take place in one and the same space of time, are seen to vary from the above mentioned causes. The waters are then withdrawn into the fissures which start from the depths of the sea and which ramify inside the body of the earth, corresponding to the sources of rivers, which are constantly taking from the bottom of the sea the water which has flowed into it. A sea of water is incessantly being drawn off from the surface of the sea. And if you should think that the moon, rising at the Eastern end of the Mediterranean sea must there begin to attract to herself the waters of the sea, it would follow that we must at once see the effect of it at the Eastern end of that sea. Again, as the Mediterranean sea is about the eighth part of the circumference of the aqueous sphere, being 3000 miles long, while the flow and ebb only occur 4 times in 24 hours, these results would not agree with the time of 24 hours, unless this Mediterranean sea were six thousand miles in length; because if such a superabundance of water had to pass through the straits of Gibraltar in running behind the moon, the rush of the water through that strait would be so great, and would rise to such a height, that beyond the straits it would for many miles rush so violently into the ocean as to cause floods and tremendous seething, so that it would be impossible to pass through. This agitated ocean would afterwards return the waters it had received with equal fury to the place they had come from, so that no one ever could pass through those straits. Now experience shows that at every hour they are passed in safety, but when the wind sets in the same direction as the current, the strong ebb increases [Footnote 23: In attempting to get out of the Mediterranean, vessels are sometimes detained for a considerable time; not merely by the causes mentioned by Leonardo but by the constant current flowing eastwards through the middle of the straits of Gibraltar.]. The sea does not raise the water that has issued from the straits, but it checks them and this retards the tide; then it makes up with furious haste for the time it has lost until the end of the ebb movement.

That the flow and ebb are not general; for on the shore at Genoa there is none, at Venice two braccia, between England and Flanders 18 braccia. That in the straits of Sicily the current is very strong because all the waters from the rivers that flow into the Adriatic pass there.

[Footnote: A few more recent data may be given here to facilitate comparison. In the Adriatic the tide rises 2 and 1/2 feet, at Terracina 1 1/4. In the English channel between Calais and Kent it rises from 18 to 20 feet. In the straits of Messina it rises no more than 2 1/2 feet, and that only in stormy weather, but the current is all the stronger. When Leonardo accounts for this by the southward flow of all the Italian rivers along the coasts, the explanation is at least based on a correct observation; namely that a steady current flows southwards along the coast of Calabria and another northwards, along the shores of Sicily; he seems to infer, from the direction of the fust, that the tide in the Adriatic is caused by it.]

960.

In the West, near to Flanders, the sea rises and decreases every 6 hours about 20 braccia, and 22 when the moon is in its favour; but 20 braccia is the general rule, and this rule, as it is evident, cannot have the moon for its cause. This variation in the increase and decrease of the sea every 6 hours may arise from the damming up of the waters, which are poured into the Mediterranean by the quantity of rivers from Africa, Asia and Europe, which flow into that sea, and the waters which are given to it by those rivers; it pours them to the ocean through the straits of Gibraltar, between Abila and Calpe [Footnote 5: *Abila*, Lat. *Abyla*, Gr. , now *Sierra Ximiera* near Ceuta; *Calpe*, Lat. *Calpe*. Gr., now Gibraltar. Leonardo here uses the ancient names of the rocks, which were known as the Pillars of Hercules.]. That ocean extends to the island of England and others farther North, and it becomes dammed up and kept high in various gulfs. These, being seas of which the surface is remote from the centre of the earth, have acquired a weight, which as it is greater than the force of the incoming waters which cause it, gives this water an impetus in the contrary direction to that in which it came and it is borne back to meet the waters coming out of the straits; and this it does most against the straits of Gibraltar; these, so long as this goes on, remain dammed up and all the water which is poured out meanwhile by the aforementioned rivers, is pent up [in the Mediterranean]; and this might be assigned as the cause of its flow and ebb, as is shown in the 21st of the 4th of my theory.

III.

SUBTERRANEAN WATER COURSES.

Theory of the circulation of the waters (961. 962).

961.

Very large rivers flow under ground.

962.

This is meant to represent the earth cut through in the middle, showing the depths of the sea and of the earth; the waters start from the bottom of the seas, and ramifying through the earth they rise to the summits of the mountains, flowing back by the rivers and returning to the sea.

Observations in support of the hypothesis (963-969).

963.

The waters circulate with constant motion from the utmost depths of the sea to the highest summits of the mountains, not obeying the nature of heavy matter; and in this case it acts as does the blood of animals which is always moving from the sea of the heart and flows to the top of their heads; and here it is that veins burst — as one may see when a vein bursts in the nose, that all the blood from below rises to the level of the burst vein. When the water rushes out of a burst vein in the earth it obeys the nature of other things heavier than the air, whence it always seeks the lowest places. These waters traverse the body of the earth with infinite ramifications.

[Footnote: The greater part of this passage has been given as No. 849 in the section on Anatomy.]

964.

The same cause which stirs the humours in every species of animal body and by which every injury is repaired, also moves the waters from the utmost depth of the sea to the greatest heights.

965.

It is the property of water that it constitutes the vital human of this arid earth; and the cause which moves it through its ramified veins, against the natural course of heavy matters, is the same property which moves the humours in every species of animal body. But that which crowns our wonder in contemplating it is, that it rises from the utmost depths of the sea to the highest tops of the mountains, and flowing from the opened veins returns to the low seas; then once more, and with extreme swiftness, it mounts again and returns by the same descent, thus rising from the inside to the outside, and going round from the lowest to the highest, from whence it rushes down in a natural course. Thus by these two movements combined in a constant circulation, it travels through the veins of the earth.

966.

WHETHER WATER RISES FROM THE SEA TO THE TOPS OF MOUNTAINS.

The water of the ocean cannot make its way from the bases to the tops of the mountains which bound it, but only so much rises as the dryness of the mountain attracts. And if, on the contrary, the rain, which penetrates from the summit of the mountain to the base, which is the boundary of the sea, descends and softens the slope opposite to the said mountain and constantly draws the water, like a syphon [Footnote 11: Cicognola, Syphon. See Vol. I, Pl. XXIV, No. 1.] which pours through its longest side, it must be this which draws up the water of the sea; thus if $s n$ were the surface of the sea, and the rain descends from the top of the mountain a to n on one side, and on the other sides it descends from a to m , without a doubt this would occur after the manner of distilling through felt, or as happens through the tubes called syphons [Footnote 17: Cicognola, Syphon. See Vol. I, Pl. XXIV, No. 1.]. And at all times the water which has softened the

mountain, by the great rain which runs down the two opposite sides, would constantly attract the rain *a n*, on its longest side together with the water from the sea, if that side of the mountain *a m* were longer than the other *a n*; but this cannot be, because no part of the earth which is not submerged by the ocean can be lower than that ocean.

967.

OF SPRINGS OF WATER ON THE TOPS OF MOUNTAINS.

It is quite evident that the whole surface of the ocean — when there is no storm — is at an equal distance from the centre of the earth, and that the tops of the mountains are farther from this centre in proportion as they rise above the surface of that sea; therefore if the body of the earth were not like that of man, it would be impossible that the waters of the sea — being so much lower than the mountains — could by their nature rise up to the summits of these mountains. Hence it is to be believed that the same cause which keeps the blood at the top of the head in man keeps the water at the summits of the mountains.

[Footnote: This conception of the rising of the blood, which has given rise to the comparison, was recognised as erroneous by Leonardo himself at a later period. It must be remembered that the MS. A, from which these passages are taken, was written about twenty years earlier than the MS. Leic. (Nos. 963 and 849) and twenty-five years before the MS. W. An. IV.

There is, in the original a sketch with No. 968 which is not reproduced. It represents a hill of the same shape as that shown at No. 982. There are veins, or branched streams, on the side of the hill, like those on the skull Pl. CVIII, No. 4]

968.

IN CONFIRMATION OF WHY THE WATER GOES TO THE TOPS OF MOUNTAINS.

I say that just as the natural heat of the blood in the veins keeps it in the head of

man, — for when the man is dead the cold blood sinks to the lower parts — and when the sun is hot on the head of a man the blood increases and rises so much, with other humours, that by pressure in the veins pains in the head are often caused; in the same way veins ramify through the body of the earth, and by the natural heat which is distributed throughout the containing body, the water is raised through the veins to the tops of mountains. And this water, which passes through a closed conduit inside the body of the mountain like a dead thing, cannot come forth from its low place unless it is warmed by the vital heat of the spring time. Again, the heat of the element of fire and, by day, the heat of the sun, have power to draw forth the moisture of the low parts of the mountains and to draw them up, in the same way as it draws the clouds and collects their moisture from the bed of the sea.

969.

That many springs of salt water are found at great distances from the sea; this might happen because such springs pass through some mine of salt, like that in Hungary where salt is hewn out of vast caverns, just as stone is hewn.

[Footnote: The great mine of Wieliczka in Galicia, out of which a million cwt. of rock-salt are annually dug out, extends for 3000 metres from West to East, and 1150 metres from North to South.]

IV.

OF RIVERS.

On the way in which the sources of rivers are fed.

970.

OF THE ORIGIN OF RIVERS.

The body of the earth, like the bodies of animals, is intersected with ramifications of waters which are all in connection and are constituted to give

nutriment and life to the earth and to its creatures. These come from the depth of the sea and, after many revolutions, have to return to it by the rivers created by the bursting of these springs; and if you chose to say that the rains of the winter or the melting of the snows in summer were the cause of the birth of rivers, I could mention the rivers which originate in the torrid countries of Africa, where it never rains — and still less snows — because the intense heat always melts into air all the clouds which are borne thither by the winds. And if you chose to say that such rivers, as increase in July and August, come from the snows which melt in May and June from the sun's approach to the snows on the mountains of Scythia [Footnote 9: Scythia means here, as in Ancient Geography, the whole of the Northern part of Asia as far as India.], and that such meltings come down into certain valleys and form lakes, into which they enter by springs and subterranean caves to issue forth again at the sources of the Nile, this is false; because Scythia is lower than the sources of the Nile, and, besides, Scythia is only 400 miles from the Black sea and the sources of the Nile are 3000 miles distant from the sea of Egypt into which its waters flow.

The tide in estuaries.

971.

Book 9, of the meeting of rivers and of their ebb and flow. The cause is the same in the sea, where it is caused by the straits of Gibraltar; and again it is caused by whirlpools.

If two rivers meet together to form a straight line, and then below two right angles take their course together, the flow and ebb will happen now in one river and now in the other above their confluence, and principally if the outlet for their united volume is no swifter than when they were separate. Here occur 4 instances.

[Footnote: The first two lines of this passage have already been given as No. 957. In the margin, near line 3 of this passage, the text given as No. 919 is written.]

On the alterations, caused in the courses of rivers by their confluence (972-

974).

972.

When a smaller river pours its waters into a larger one, and that larger one flows from the opposite direction, the course of the smaller river will bend up against the approach of the larger river; and this happens because, when the larger river fills up all its bed with water, it makes an eddy in front of the mouth of the other river, and so carries the water poured in by the smaller river with its own. When the smaller river pours its waters into the larger one, which runs across the current at the mouth of the smaller river, its waters will bend with the downward movement of the larger river. [Footnote: In the original sketches the word *Arno* is written at the spot here marked *A*, at *R. Rifredi*, and at *M. Mugnone*.]

973.

When the fulness of rivers is diminished, then the acute angles formed at the junction of their branches become shorter at the sides and wider at the point; like the current *a n* and the current *d n*, which unite in *n* when the river is at its greatest fulness. I say, that when it is in this condition if, before the fullest time, *d n* was lower than *a n*, at the time of fulness *d n* will be full of sand and mud. When the water *d n* falls, it will carry away the mud and remain with a lower bottom, and the channel *a n* finding itself the higher, will fling its waters into the lower, *d n*, and will wash away all the point of the sand-spit *b n c*, and thus the angle *a c d* will remain larger than the angle *a n d* and the sides shorter, as I said before.

[Footnote: Above the first sketch we find, in the original, this note: "*Sopra il pote rubaconte alla torricella*"; and by the second, which represents a pier of a bridge, "*Sotto l'ospedal del ceppo*."]]

974.

WATER.

OF THE MOVEMENT OF A SUDDEN RUSH MADE BY A RIVER IN ITS BED PREVIOUSLY DRY.

In proportion as the current of the water given forth by the draining of the lake is slow or rapid in the dry river bed, so will this river be wider or narrower, or shallower or deeper in one place than another, according to this proposition: the flow and ebb of the sea which enters the Mediterranean from the ocean, and of the rivers which meet and struggle with it, will raise their waters more or less in proportion as the sea is wider or narrower.

[Footnote: In the margin is a sketch of a river which winds so as to form islands.]

Whirlpools.

975.

Whirlpools, that is to say caverns; that is to say places left by precipitated waters.

On the alterations in the channels of rivers.

976.

OF THE VIBRATION OF THE EARTH.

The subterranean channels of waters, like those which exist between the air and the earth, are those which unceasingly wear away and deepen the beds of their currents.

The origin of the sand in rivers (977. 978).

977.

A river that flows from mountains deposits a great quantity of large stones in its bed, which still have some of their angles and sides, and in the course of its

flow it carries down smaller stones with the angles more worn; that is to say the large stones become smaller. And farther on it deposits coarse gravel and then smaller, and as it proceeds this becomes coarse sand and then finer, and going on thus the water, turbid with sand and gravel, joins the sea; and the sand settles on the sea-shores, being cast up by the salt waves; and there results the sand of so fine a nature as to seem almost like water, and it will not stop on the shores of the sea but returns by reason of its lightness, because it was originally formed of rotten leaves and other very light things. Still, being almost — as was said — of the nature of water itself, it afterwards, when the weather is calm, settles and becomes solid at the bottom of the sea, where by its fineness it becomes compact and by its smoothness resists the waves which glide over it; and in this shells are found; and this is white earth, fit for pottery.

978.

All the torrents of water flowing from the mountains to the sea carry with them the stones from the hills to the sea, and by the influx of the sea-water towards the mountains; these stones were thrown back towards the mountains, and as the waters rose and retired, the stones were tossed about by it and in rolling, their angles hit together; then as the parts, which least resisted the blows, were worn off, the stones ceased to be angular and became round in form, as may be seen on the banks of the Elsa. And those remained larger which were less removed from their native spot; and they became smaller, the farther they were carried from that place, so that in the process they were converted into small pebbles and then into sand and at last into mud. After the sea had receded from the mountains the brine left by the sea with other humours of the earth made a concretion of these pebbles and this sand, so that the pebbles were converted into rock and the sand into tufa. And of this we see an example in the Adda where it issues from the mountains of Como and in the Ticino, the Adige and the Oglio coming from the German Alps, and in the Arno at Monte Albano [Footnote 13: At the foot of *Monte Albano* lies Vinci, the birth place of Leonardo. Opposite, on the other bank of the Arno, is *Monte Lupo*.], near Monte Lupo and Capraia where the rocks, which are very large, are all of conglomerated pebbles of various kinds and colours.

ON MOUNTAINS.

The formation of mountains (979-983).

979.

Mountains are made by the currents of rivers.

Mountains are destroyed by the currents of rivers.

[Footnote: Compare 789.]

980.

That the Northern bases of some Alps are not yet petrified. And this is plainly to be seen where the rivers, which cut through them, flow towards the North; where they cut through the strata in the living stone in the higher parts of the mountains; and, where they join the plains, these strata are all of potter's clay; as is to be seen in the valley of Lamona where the river Lamona, as it issues from the Appenines, does these things on its banks.

That the rivers have all cut and divided the mountains of the great Alps one from the other. This is visible in the order of the stratified rocks, because from the summits of the banks, down to the river the correspondence of the strata in the rocks is visible on either side of the river. That the stratified stones of the mountains are all layers of clay, deposited one above the other by the various floods of the rivers. That the different size of the strata is caused by the difference in the floods — that is to say greater or lesser floods.

981.

The summits of mountains for a long time rise constantly.

The opposite sides of the mountains always approach each other below; the depths of the valleys which are above the sphere of the waters are in the course of time constantly getting nearer to the centre of the world.

In an equal period, the valleys sink much more than the mountains rise.

The bases of the mountains always come closer together.

In proportion as the valleys become deeper, the more quickly are their sides worn away.

982.

In every concavity at the summit of the mountains we shall always find the divisions of the strata in the rocks.

983.

OF THE SEA WHICH ENCIRCLES THE EARTH.

I find that of old, the state of the earth was that its plains were all covered up and hidden by salt water. [Footnote: This passage has already been published by Dr. M. JORDAN: *Das Malerbuch des L. da Vinci*, Leipzig 1873, p. 86. However, his reading of the text differs from mine.]

The authorities for the study of the structure of the earth.

984.

Since things are much more ancient than letters, it is no marvel if, in our day, no records exist of these seas having covered so many countries; and if, moreover, some records had existed, war and conflagrations, the deluge of waters, the changes of languages and of laws have consumed every thing ancient. But sufficient for us is the testimony of things created in the salt waters, and found again in high mountains far from the seas.

VI.

GEOLOGICAL PROBLEMS.

985.

In this work you have first to prove that the shells at a thousand braccia of elevation were not carried there by the deluge, because they are seen to be all at

one level, and many mountains are seen to be above that level; and to inquire whether the deluge was caused by rain or by the swelling of the sea; and then you must show how, neither by rain nor by swelling of the rivers, nor by the overflow of this sea, could the shells — being heavy objects — be floated up the mountains by the sea, nor have carried there by the rivers against the course of their waters.

Doubts about the deluge.

986.

A DOUBTFUL POINT.

Here a doubt arises, and that is: whether the deluge, which happened at the time of Noah, was universal or not. And it would seem not, for the reasons now to be given: We have it in the Bible that this deluge lasted 40 days and 40 nights of incessant and universal rain, and that this rain rose to ten cubits above the highest mountains in the world. And if it had been that the rain was universal, it would have covered our globe which is spherical in form. And this spherical surface is equally distant in every part, from the centre of its sphere; hence the sphere of the waters being under the same conditions, it is impossible that the water upon it should move, because water, in itself, does not move unless it falls; therefore how could the waters of such a deluge depart, if it is proved that it has no motion? and if it departed how could it move unless it went upwards? Here, then, natural reasons are wanting; hence to remove this doubt it is necessary to call in a miracle to aid us, or else to say that all this water was evaporated by the heat of the sun.

[Footnote: The passages, here given from the MS. Leic., have hitherto remained unknown. Some preliminary notes on the subject are to be found in MS. F 80a and 80b; but as compared with the fuller treatment here given, they are, it seems to me, of secondary interest. They contain nothing that is not repeated here more clearly and fully. LIBRI, *Histoire des Sciences mathematiques III*, pages 218 — 221, has printed the text of F 80a and 80b, therefore it seemed desirable to give my reasons for not inserting it in this work.]

That marine shells could not go up the mountains.

OF THE DELUGE AND OF MARINE SHELLS.

If you were to say that the shells which are to be seen within the confines of Italy now, in our days, far from the sea and at such heights, had been brought there by the deluge which left them there, I should answer that if you believe that this deluge rose 7 cubits above the highest mountains — as he who measured it has written — these shells, which always live near the sea-shore, should have been left on the mountains; and not such a little way from the foot of the mountains; nor all at one level, nor in layers upon layers. And if you were to say that these shells are desirous of remaining near to the margin of the sea, and that, as it rose in height, the shells quitted their first home, and followed the increase of the waters up to their highest level; to this I answer, that the cockle is an animal of not more rapid movement than the snail is out of water, or even somewhat slower; because it does not swim, on the contrary it makes a furrow in the sand by means of its sides, and in this furrow it will travel each day from 3 to 4 braccia; therefore this creature, with so slow a motion, could not have travelled from the Adriatic sea as far as Monferrato in Lombardy [Footnote: *Monferrato di Lombardia*. The range of hills of Monferrato is in Piedmont, and Casale di Monferrato belonged, in Leonardo's time, to the Marchese di Mantova.], which is 250 miles distance, in 40 days; which he has said who took account of the time. And if you say that the waves carried them there, by their gravity they could not move, excepting at the bottom. And if you will not grant me this, confess at least that they would have to stay at the summits of the highest mountains, in the lakes which are enclosed among the mountains, like the lakes of Lario, or of Como and il Maggiore [Footnote: *Lago di Lario*. Lacus Larius was the name given by the Romans to the lake of Como. It is evident that it is here a slip of the pen since the the words in the MS. are: "*Come Lago di Lario o'l Magare e di Como*," In the MS. after line 16 we come upon a digression treating of the weight of water; this has here been omitted. It is 11 lines long.] and of Fiesole, and of Perugia, and others.

And if you should say that the shells were carried by the waves, being empty and dead, I say that where the dead went they were not far removed from the living; for in these mountains living ones are found, which are recognisable by the shells being in pairs; and they are in a layer where there are no dead ones;

and a little higher up they are found, where they were thrown by the waves, all the dead ones with their shells separated, near to where the rivers fell into the sea, to a great depth; like the Arno which fell from the Gonfolina near to Monte Lupo [Footnote: *Monte Lupo*, compare 970, 13; it is between Empoli and Florence.], where it left a deposit of gravel which may still be seen, and which has agglomerated; and of stones of various districts, natures, and colours and hardness, making one single conglomerate. And a little beyond the sandstone conglomerate a tufa has been formed, where it turned towards Castel Florentino; farther on, the mud was deposited in which the shells lived, and which rose in layers according to the levels at which the turbid Arno flowed into that sea. And from time to time the bottom of the sea was raised, depositing these shells in layers, as may be seen in the cutting at Colle Gonzoli, laid open by the Arno which is wearing away the base of it; in which cutting the said layers of shells are very plainly to be seen in clay of a bluish colour, and various marine objects are found there. And if the earth of our hemisphere is indeed raised by so much higher than it used to be, it must have become by so much lighter by the waters which it lost through the rift between Gibraltar and Ceuta; and all the more the higher it rose, because the weight of the waters which were thus lost would be added to the earth in the other hemisphere. And if the shells had been carried by the muddy deluge they would have been mixed up, and separated from each other amidst the mud, and not in regular steps and layers — as we see them now in our time.

The marine shells were not produced away from the sea.

988.

As to those who say that shells existed for a long time and were born at a distance from the sea, from the nature of the place and of the cycles, which can influence a place to produce such creatures — to them it may be answered: such an influence could not place the animals all on one line, except those of the same sort and age; and not the old with the young, nor some with an operculum and others without their operculum, nor some broken and others whole, nor some filled with sea-sand and large and small fragments of other shells inside the whole shells which remained open; nor the claws of crabs without the rest of their bodies; nor the shells of other species stuck on to them like animals which have moved about on them; since the traces of their track still remain, on the outside, after the manner of worms in the wood which they ate into. Nor would there be found among them the bones and teeth of fish which some call arrows

and others serpents' tongues, nor would so many [Footnote: I. Scilla argued against this hypothesis, which was still accepted in his days; see: *La vana Speculazione*, Napoli 1670.] portions of various animals be found all together if they had not been thrown on the sea shore. And the deluge cannot have carried them there, because things that are heavier than water do not float on the water. But these things could not be at so great a height if they had not been carried there by the water, such a thing being impossible from their weight. In places where the valleys have not been filled with salt sea water shells are never to be seen; as is plainly visible in the great valley of the Arno above Gonfolina; a rock formerly united to Monte Albano, in the form of a very high bank which kept the river pent up, in such a way that before it could flow into the sea, which was afterwards at its foot, it formed two great lakes; of which the first was where we now see the city of Florence together with Prato and Pistoia, and Monte Albano. It followed the rest of its bank as far as where Serravalle now stands. >From the Val d'Arno upwards, as far as Arezzo, another lake was formed, which discharged its waters into the former lake. It was closed at about the spot where now we see Girone, and occupied the whole of that valley above for a distance of 40 miles in length. This valley received on its bottom all the soil brought down by the turbid waters. And this is still to be seen at the foot of Prato Magno; it there lies very high where the rivers have not worn it away. Across this land are to be seen the deep cuts of the rivers that have passed there, falling from the great mountain of Prato Magno; in these cuts there are no vestiges of any shells or of marine soil. This lake was joined with that of Perugia [Footnote: See PI. CXIII.]

A great quantity of shells are to be seen where the rivers flow into the sea, because on such shores the waters are not so salt owing to the admixture of the fresh water, which is poured into it. Evidence of this is to be seen where, of old, the Appenines poured their rivers into the Adriatic sea; for there in most places great quantities of shells are to be found, among the mountains, together with bluish marine clay; and all the rocks which are torn off in such places are full of shells. The same may be observed to have been done by the Arno when it fell from the rock of Gonfolina into the sea, which was not so very far below; for at that time it was higher than the top of San Miniato al Tedesco, since at the highest summit of this the shores may be seen full of shells and oysters within its flanks. The shells did not extend towards Val di Nievole, because the fresh waters of the Arno did not extend so far.

That the shells were not carried away from the sea by the deluge, because the waters which came from the earth although they drew the sea towards the earth, were those which struck its depths; because the water which goes down from the

earth, has a stronger current than that of the sea, and in consequence is more powerful, and it enters beneath the sea water and stirs the depths and carries with it all sorts of movable objects which are to be found in the earth, such as the above-mentioned shells and other similar things. And in proportion as the water which comes from the land is muddier than sea water it is stronger and heavier than this; therefore I see no way of getting the said shells so far in land, unless they had been born there. If you were to tell me that the river Loire [Footnote: Leonardo has written *Era* instead of *Loera* or *Loira* — perhaps under the mistaken idea that *Lo* was an article.], which traverses France covers when the sea rises more than eighty miles of country, because it is a district of vast plains, and the sea rises about 20 braccia, and shells are found in this plain at the distance of 80 miles from the sea; here I answer that the flow and ebb in our Mediterranean Sea does not vary so much; for at Genoa it does not rise at all, and at Venice but little, and very little in Africa; and where it varies little it covers but little of the country.

The course of the water of a river always rises higher in a place where the current is impeded; it behaves as it does where it is reduced in width to pass under the arches of a bridge.

Further researches (989-991).

989.

A CONFUTATION OF THOSE WHO SAY THAT SHELLS MAY HAVE BEEN CARRIED TO A DISTANCE OF MANY DAYS' JOURNEY FROM THE SEA BY THE DELUGE, WHICH WAS SO HIGH AS TO BE ABOVE THOSE HEIGHTS.

I say that the deluge could not carry objects, native to the sea, up to the mountains, unless the sea had already increased so as to create inundations as high up as those places; and this increase could not have occurred because it would cause a vacuum; and if you were to say that the air would rush in there, we have already concluded that what is heavy cannot remain above what is light, whence of necessity we must conclude that this deluge was caused by rain water,

so that all these waters ran to the sea, and the sea did not run up the mountains; and as they ran to the sea, they thrust the shells from the shore of the sea and did not draw them to wards themselves. And if you were then to say that the sea, raised by the rain water, had carried these shells to such a height, we have already said that things heavier than water cannot rise upon it, but remain at the bottom of it, and do not move unless by the impact of the waves. And if you were to say that the waves had carried them to such high spots, we have proved that the waves in a great depth move in a contrary direction at the bottom to the motion at the top, and this is shown by the turbidity of the sea from the earth washed down near its shores. Anything which is lighter than the water moves with the waves, and is left on the highest level of the highest margin of the waves. Anything which is heavier than the water moves, suspended in it, between the surface and the bottom; and from these two conclusions, which will be amply proved in their place, we infer that the waves of the surface cannot convey shells, since they are heavier than water.

If the deluge had to carry shells three hundred and four hundred miles from the sea, it would have carried them mixed with various other natural objects heaped together; and we see at such distances oysters all together, and sea-snails, and cuttlefish, and all the other shells which congregate together, all to be found together and dead; and the solitary shells are found wide apart from each other, as we may see them on sea-shores every day. And if we find oysters of very large shells joined together and among them very many which still have the covering attached, indicating that they were left here by the sea, and still living when the strait of Gibraltar was cut through; there are to be seen, in the mountains of Parma and Piacenza, a multitude of shells and corals, full of holes, and still sticking to the rocks there. When I was making the great horse for Milan, a large sack full was brought to me in my workshop by certain peasants; these were found in that place and among them were many preserved in their first freshness.

Under ground, and under the foundations of buildings, timbers are found of wrought beams and already black. Such were found in my time in those diggings at Castel Fiorentino. And these had been in that deep place before the sand carried by the Arno into the sea, then covering the plain, had been raised to such a height; and before the plains of Casentino had been so much lowered, by the earth being constantly carried down from them.

[Footnote: These lines are written in the margin.]

And if you were to say that these shells were created, and were continually being created in such places by the nature of the spot, and of the heavens which might have some influence there, such an opinion cannot exist in a brain of

much reason; because here are the years of their growth, numbered on their shells, and there are large and small ones to be seen which could not have grown without food, and could not have fed without motion — and here they could not move [Footnote: These lines are written in the margin.]

990.

That in the drifts, among one and another, there are still to be found the traces of the worms which crawled upon them when they were not yet dry. And all marine clays still contain shells, and the shells are petrified together with the clay. From their firmness and unity some persons will have it that these animals were carried up to places remote from the sea by the deluge. Another sect of ignorant persons declare that Nature or Heaven created them in these places by celestial influences, as if in these places we did not also find the bones of fishes which have taken a long time to grow; and as if, we could not count, in the shells of cockles and snails, the years and months of their life, as we do in the horns of bulls and oxen, and in the branches of plants that have never been cut in any part. Besides, having proved by these signs the length of their lives, it is evident, and it must be admitted, that these animals could not live without moving to fetch their food; and we find in them no instrument for penetrating the earth or the rock where we find them enclosed. But how could we find in a large snail shell the fragments and portions of many other sorts of shells, of various sorts, if they had not been thrown there, when dead, by the waves of the sea like the other light objects which it throws on the earth? Why do we find so many fragments and whole shells between layer and layer of stone, if this had not formerly been covered on the shore by a layer of earth thrown up by the sea, and which was afterwards petrified? And if the deluge before mentioned had carried them to these parts of the sea, you might find these shells at the boundary of one drift but not at the boundary between many drifts. We must also account for the winters of the years during which the sea multiplied the drifts of sand and mud brought down by the neighbouring rivers, by washing down the shores; and if you chose to say that there were several deluges to produce these rifts and the shells among them, you would also have to affirm that such a deluge took place every year. Again, among the fragments of these shells, it must be presumed that in those places there were sea coasts, where all the shells were thrown up, broken, and divided, and never in pairs, since they are found alive in the sea, with two valves, each serving as a lid to the other; and in the drifts of rivers and on the shores of the sea they are found in fragments. And within the limits of the

separate strata of rocks they are found, few in number and in pairs like those which were left by the sea, buried alive in the mud, which subsequently dried up and, in time, was petrified.

991.

And if you choose to say that it was the deluge which carried these shells away from the sea for hundreds of miles, this cannot have happened, since that deluge was caused by rain; because rain naturally forces the rivers to rush towards the sea with all the things they carry with them, and not to bear the dead things of the sea shores to the mountains. And if you choose to say that the deluge afterwards rose with its waters above the mountains, the movement of the sea must have been so sluggish in its rise against the currents of the rivers, that it could not have carried, floating upon it, things heavier than itself; and even if it had supported them, in its receding it would have left them strewn about, in various spots. But how are we to account for the corals which are found every day towards Monte Ferrato in Lombardy, with the holes of the worms in them, sticking to rocks left uncovered by the currents of rivers? These rocks are all covered with stocks and families of oysters, which as we know, never move, but always remain with one of their halves stuck to a rock, and the other they open to feed themselves on the animalcules that swim in the water, which, hoping to find good feeding ground, become the food of these shells. We do not find that the sand mixed with seaweed has been petrified, because the weed which was mingled with it has shrunk away, and this the Po shows us every day in the debris of its banks.

Other problems (992-994).

992.

Why do we find the bones of great fishes and oysters and corals and various other shells and sea-snails on the high summits of mountains by the sea, just as we find them in low seas?

993.

You now have to prove that the shells cannot have originated if not in salt

water, almost all being of that sort; and that the shells in Lombardy are at four levels, and thus it is everywhere, having been made at various times. And they all occur in valleys that open towards the seas.

994.

>From the two lines of shells we are forced to say that the earth indignantly submerged under the sea and so the first layer was made; and then the deluge made the second.

[Footnote: This note is in the early writing of about 1470 — 1480. On the same sheet are the passages No. 1217 and 1219. Compare also No. 1339. All the foregoing chapters are from Manuscripts of about 1510. This explains the want of connection and the contradiction between this and the foregoing texts.]

VII.

ON THE ATMOSPHERE.

Constituents of the atmosphere.

995.

That the brightness of the air is occasioned by the water which has dissolved itself in it into imperceptible molecules. These, being lighted by the sun from the opposite side, reflect the brightness which is visible in the air; and the azure which is seen in it is caused by the darkness that is hidden beyond the air.

[Footnote: Compare Vol. I, No. 300.]

On the motion of air (996 — 999).

996.

That the return eddies of wind at the mouth of certain valleys strike upon the waters and scoop them out in a great hollow, whirl the water into the air in the form of a column, and of the colour of a cloud. And I saw this thing happen on a sand bank in the Arno, where the sand was hollowed out to a greater depth than

the stature of a man; and with it the gravel was whirled round and flung about for a great space; it appeared in the air in the form of a great bell-tower; and the top spread like the branches of a pine tree, and then it bent at the contact of the direct wind, which passed over from the mountains.

997.

The element of fire acts upon a wave of air in the same way as the air does on water, or as water does on a mass of sand — that is earth; and their motions are in the same proportions as those of the motors acting upon them.

998.

OF MOTION.

I ask whether the true motion of the clouds can be known by the motion of their shadows; and in like manner of the motion of the sun.

999.

To know better the direction of the winds. [Footnote: In connection with this text I may here mention a hygrometer, drawn and probably invented by Leonardo. A facsimile of this is given in Vol. I, p. 297 with the note: '*Modi di pesare l'arie eddi sapere quando s'a arrompere il tepo*' (Mode of weighing the air and of knowing when the weather will change); by the sponge "*Spugnea*" is written.]

The globe an organism.

1000.

Nothing originates in a spot where there is no sentient, vegetable and rational life; feathers grow upon birds and are changed every year; hairs grow upon animals and are changed every year, excepting some parts, like the hairs of the beard in lions, cats and their like. The grass grows in the fields, and the leaves on

the trees, and every year they are, in great part, renewed. So that we might say that the earth has a spirit of growth; that its flesh is the soil, its bones the arrangement and connection of the rocks of which the mountains are composed, its cartilage the tufa, and its blood the springs of water. The pool of blood which lies round the heart is the ocean, and its breathing, and the increase and decrease of the blood in the pulses, is represented in the earth by the flow and ebb of the sea; and the heat of the spirit of the world is the fire which pervades the earth, and the seat of the vegetative soul is in the fires, which in many parts of the earth find vent in baths and mines of sulphur, and in volcanoes, as at Mount Aetna in Sicily, and in many other places.

[Footnote: Compare No. 929.]

XVIII. NAVAL WARFARE. — MECHANICAL APPLIANCES. — MUSIC.

Such theoretical questions, as have been laid before the reader in Sections XVI and XVII, though they were the chief subjects of Leonardo's studies of the sea, did not exclusively claim his attention. A few passages have been collected at the beginning of this section, which prove that he had turned his mind to the practical problems of navigation, and more especially of naval warfare. What we know for certain of his life gives us no data, it is true, as to when or where these matters came under his consideration; but the fact remains certain both from these notes in his manuscripts, and from the well known letter to Ludovico il Moro (No. 1340), in which he expressly states that he is as capable as any man, in this very department.

The numerous notes as to the laws and rationale of the flight of birds, are scattered through several note-books. An account of these is given in the Bibliography of the manuscripts at the end of this work. It seems probable that the idea which led him to these investigations was his desire to construct a flying or aerial machine for man. At the same time it must be admitted that the notes on the two subjects are quite unconnected in the manuscripts, and that those on the flight of birds are by far the most numerous and extensive. The two most important passages that treat of the construction of a flying machine are those already published as Tav. XVI, No. 1 and Tav. XVIII in the "Saggio delle opere di Leonardo da Vinci" (Milan 1872). The passages — Nos. 1120-1125 — here printed for the first time and hitherto unknown — refer to the same subject and, with the exception of one already published in the Saggio — No. 1126 — they are, so far as I know, the only notes, among the numerous observations on the flight of birds, in which the phenomena are incidentally and expressly connected with the idea of a flying machine.

The notes on machines of war, the construction of fortifications, and similar matters which fall within the department of the Engineer, have not been included in this work, for the reasons given on page 26 of this Vol. An exception has been made in favour of the passages Nos. 1127 and 1128, because they have a more general interest, as bearing on the important question: whence the Master derived his knowledge of these matters. Though it would be rash to assert that

Leonardo was the first to introduce the science of mining into Italy, it may be confidently said that he is one of the earliest writers who can be proved to have known and understood it; while, on the other hand, it is almost beyond doubt that in the East at that time, the whole science of besieging towns and mining in particular, was far more advanced than in Europe. This gives a peculiar value to the expressions used in No. 1127.

I have been unable to find in the manuscripts any passage whatever which throws any light on Leonardo's great reputation as a musician. Nothing therein illustrates VASARPS well-known statement: Avvenne che morto Giovan Galeazze duca di Milano, e creato Lodovico Sforza nel grado medesimo anno 1494, fu condotto a Milano con gran riputazione Lionardo al duca, il quale molto si dilettaua del suono della lira, perche sonasse; e Lionardo porto quello strumento ch'egli aveva di sua mano fabbricato d'argento gran parte, in forma d'un teschio di cavallo, cosa bizzarra e nuova, acciocche l'armonia fosse con maggior tuba e piu sonora di voce; laonde supero tutti i musici che quivi erano concorsi a sonare.

The only notes on musical matters are those given as Nos. 1129 and 1130, which explain certain arrangements in instruments.

The ship's logs of Vitruvius, of Alberti and of Leonardo

1113.

ON MOVEMENTS; — TO KNOW HOW MUCH A SHIP ADVANCES IN AN HOUR.

The ancients used various devices to ascertain the distance gone by a ship each hour, among which Vitruvius [Footnote 6: See VITRUVIUS, *De Architectura lib. X. C. 14* (p. 264 in the edition of Rose and Muller-Strubing). The German edition published at Bale in 1543 has, on fol. 596, an illustration of the contrivance, as described by Vitruvius.] gives one in his work on Architecture which is just as fallacious as all the others; and this is a mill wheel which touches the waves of the sea at one end and in each complete revolution describes a straight line which represents the circumference of the wheel extended to a straightness. But this invention is of no worth excepting on the smooth and motionless surface of lakes. But if the water moves together with the ship at an equal rate, then the wheel remains motionless; and if the motion of the water is more or less rapid than that of the ship, then neither has the wheel the

same motion as the ship so that this invention is of but little use. There is another method tried by experiment with a known distance between one island and another; and this is done by a board or under the pressure of wind which strikes on it with more or less swiftness. This is in Battista Alberti [Footnote 25: LEON BATTISTA ALBERTI, *De Architectura lib. V.*, c. 12 treats '*de le navi e parti loro*', but there is no reference to the machine, mentioned by Leonardo. Alberti says here: *Noi abbiamo trattato lungamente in altro luogo de' modi de le navi, ma in questo luogo ne abbiamo detto quel tanto che si bisogna*. To this the following note is added in the most recent Italian edition: *Questo libro e tuttora inedito e porta il titolo, secondo Gesnero di 'Liber navis'*.].

Battista Alberti's method which is made by experiment on a known distance between one island and another. But such an invention does not succeed excepting on a ship like the one on which the experiment was made, and it must be of the same burden and have the same sails, and the sails in the same places, and the size of the waves must be the same. But my method will serve for any ship, whether with oars or sails; and whether it be small or large, broad or long, or high or low, it always serves [Footnote 52: Leonardo does not reveal the method invented by him.].

Methods of staying and moving in water

1114.

How an army ought to cross rivers by swimming with air-bags ... How fishes swim [Footnote 2: Compare No. 821.]; of the way in which they jump out of the water, as may be seen with dolphins; and it seems a wonderful thing to make a leap from a thing which does not resist but slips away. Of the swimming of animals of a long form, such as eels and the like. Of the mode of swimming against currents and in the rapid falls of rivers. Of the mode of swimming of fishes of a round form. How it is that animals which have not long hind quarters cannot swim. How it is that all other animals which have feet with toes, know by nature how to swim, excepting man. In what way man ought to learn to swim. Of the way in which man may rest on the water. How man may protect himself against whirlpools or eddies in the water, which drag him down. How a man dragged to the bottom must seek the reflux which will throw him up from the depths. How he ought to move his arms. How to swim on his back. How he can and how he cannot stay under water unless he can hold his breath . How by means of a certain machine many people may stay some time under water. How and why I do not describe my method of remaining under water, or how long I

can stay without eating; and I do not publish nor divulge these by reason of the evil nature of men who would use them as means of destruction at the bottom of the sea, by sending ships to the bottom, and sinking them together with the men in them. And although I will impart others, there is no danger in them; because the mouth of the tube, by which you breathe, is above the water supported on bags or corks .

[Footnote: L. 13-19 will also be found in Vol. I No. 1.]

On naval warfare (1115. 1116).

1115.

Supposing in a battle between ships and galleys that the ships are victorious by reason of the high of their tops, you must haul the yard up almost to the top of the mast, and at the extremity of the yard, that is the end which is turned towards the enemy, have a small cage fastened, wrapped up below and all round in a great mattress full of cotton so that it may not be injured by the bombs; then, with the capstan, haul down the opposite end of this yard and the top on the opposite side will go up so high, that it will be far above the round-top of the ship, and you will easily drive out the men that are in it. But it is necessary that the men who are in the galley should go to the opposite side of it so as to afford a counterpoise to the weight of the men placed inside the cage on the yard.

1116.

If you want to build an armada for the sea employ these ships to ram in the enemy's ships. That is, make ships 100 feet long and 8 feet wide, but arranged so that the left hand rowers may have their oars to the right side of the ship, and the right hand ones to the left side, as is shown at M, so that the leverage of the oars may be longer. And the said ship may be one foot and a half thick, that is made with cross beams within and without, with planks in contrary directions. And this ship must have attached to it, a foot below the water, an iron-shod spike of about the weight and size of an anvil; and this, by force of oars may, after it has given the first blow, be drawn back, and driven forward again with fury give a second blow, and then a third, and so many as to destroy the other ship.

The use of swimming belts.

1117.

A METHOD OF ESCAPING IN A TEMPEST AND SHIPWRECK AT SEA.

Have a coat made of leather, which must be double across the breast, that is having a hem on each side of about a finger breadth. Thus it will be double from the waist to the knee; and the leather must be quite air-tight. When you want to leap into the sea, blow out the skirt of your coat through the double hems of the breast; and jump into the sea, and allow yourself to be carried by the waves; when you see no shore near, give your attention to the sea you are in, and always keep in your mouth the air-tube which leads down into the coat; and if now and again you require to take a breath of fresh air, and the foam prevents you, you may draw a breath of the air within the coat.

[Footnote: AMORETTI, *Memorie Storiche*, Tav. II. B. Fig. 5, gives the same figure, somewhat altered. 6. *La canna dell' aria*. Compare Vol. I. No. I. Note]

On the gravity of water.

1118.

If the weight of the sea bears on its bottom, a man, lying on that bottom and having 1000 braccia of water on his back, would have enough to crush him.

Diving apparatus and Skating (1119-1121).

1119.

Of walking under water. Method of walking on water.

[Footnote: The two sketches belonging to this passage are given by AMORETTI, *Memorie Storiche*. Tav. II, Fig. 3 and 4.]

1120.

Just as on a frozen river a man may run without moving his feet, so a car might be made that would slide by itself.

[Footnote: The drawings of carts by the side of this text have no direct connection with the problem as stated in words. — Compare No. 1448, l. 17.]

1121.

A definition as to why a man who slides on ice does not fall. [Footnote: An indistinct sketch accompanies the passage, in the original.]

On Flying machines (1122-1126).

1122.

Man when flying must stand free from the waist upwards so as to be able to balance himself as he does in a boat so that the centre of gravity in himself and in the machine may counterbalance each other, and be shifted as necessity demands for the changes of its centre of resistance.

1123.

Remember that your flying machine must imitate no other than the bat, because the web is what by its union gives the armour, or strength to the wings.

If you imitate the wings of feathered birds, you will find a much stronger structure, because they are pervious; that is, their feathers are separate and the air passes through them. But the bat is aided by the web that connects the whole and is not pervious.

1124.

TO ESCAPE THE PERIL OF DESTRUCTION.

Destruction to such a machine may occur in two ways; of which the first is the breaking of the machine. The second would be when the machine should turn on its edge or nearly on its edge, because it ought always to descend in a highly oblique direction, and almost exactly balanced on its centre. As regards the first — the breaking of the machine — , that may be prevented by making it as strong as possible; and in whichever direction it may tend to turn over, one centre must be very far from the other; that is, in a machine 30 braccia long the centres must be 4 braccia one from the other.

[Footnote: Compare No. 1428.]

1125.

Bags by which a man falling from a height of 6 braccia may avoid hurting himself, by a fall whether into water or on the ground; and these bags, strung together like a rosary, are to be fixed on one's back.

1126.

An object offers as much resistance to the air as the air does to the object. You may see that the beating of its wings against the air supports a heavy eagle in the highest and rarest atmosphere, close to the sphere of elemental fire. Again you may see the air in motion over the sea, fill the swelling sails and drive heavily laden ships. From these instances, and the reasons given, a man with wings large enough and duly connected might learn to overcome the resistance of the air, and by conquering it, succeed in subjugating it and rising above it. [Footnote: A parachute is here sketched, with an explanatory remark. It is reproduced on Tav. XVI in the Saggio, and in: *Leonardo da Vinci als Ingenieur etc., Ein Beitrag zur Geschichte der Technik und der induktiven Wissenschaften, von Dr. Hermann Grothe, Berlin 1874, p. 50.*]

Of mining.

1127.

If you want to know where a mine runs, place a drum over all the places where you suspect that it is being made, and upon this drum put a couple of dice, and when you are over the spot where they are mining, the dice will jump a little on the drum at every blow which is given underground in the mining.

There are persons who, having the convenience of a river or a lake in their lands, have made, close to the place where they suspect that a mine is being made, a great reservoir of water, and have countermined the enemy, and having found them, have turned the water upon them and destroyed a great number in the mine.

Of Greek fire.

1128.

GREEK FIRE.

Take charcoal of willow, and saltpetre, and sulphuric acid, and sulphur, and pitch, with frankincense and camphor, and Ethiopian wool, and boil them all together. This fire is so ready to burn that it clings to the timbers even under water. And add to this composition liquid varnish, and bituminous oil, and turpentine and strong vinegar, and mix all together and dry it in the sun, or in an oven when the bread is taken out; and then stick it round hempen or other tow, moulding it into a round form, and studding it all over with very sharp nails. You must leave in this ball an opening to serve as a fusee, and cover it with rosin and sulphur.

Again, this fire, stuck at the top of a long plank which has one braccio length of the end pointed with iron that it may not be burnt by the said fire, is good for avoiding and keeping off the ships, so as not to be overwhelmed by their onset.

Again throw vessels of glass full of pitch on to the enemy's ships when the men in them are intent on the battle; and then by throwing similar burning balls upon them you have it in your power to burn all their ships.

[Footnote: Venturi has given another short text about the Greek fire in a French translation (Essai Section XIV). He adds that the original text is to be found in MS. B. 30 (?). Libri speaks of it in a note as follows (*Histoire des sciences mathematiques en Italie Vol. II* p. 129): *La composition du feu gregeois est une des chases qui ont ete les plus cherchees et qui sont encore les plus douteuses. On dit qu'il fut invente au septieme siecle de l'ere chretienne par l'architecte Callinique (Constantini Porphyrogenetae opera, Lugd. Batav. 1617, — in-8vo; p. 172, de admin, imper. exp. 48), et il se trouve souvent mentionne par les Historiens Byzantins. Tantot on le langait avec des machines, comme on lancerait une banche, tantot on le soufflait avec de longs tubes, comme on soufflerait un gaz ou un liquide enflamme (Annae Comnenae Alexias, p. 335, lib. XI. — Aeliani et Leonis, imperatoris tactica, Lugd.-Bat. 1613, in-4. part. 2 a, p. 322, Leonis tact. cap. 19. — Joinville, histoire du Saint Louis collect. Petitot tom. II, p. 235). Les ecrivains contemporains disent que l'eau ne pouvait pas eteindre ce feu, mais qu'avec du vinaigre et du sable on y parvenait. Suivant quelques historiens le feu gregeois etait compose de soufre et de resine. Marcus Graecus (Liber ignium, Paris, 1804, in-40) donne plusieurs manieres de le faire qui ne sont pas tres intelligibles, mais parmi lesquelles on trouve la composition de la poudre a canon. Leonard de Vinci (MSS. de Leonard de Vinci, vol. B. f. 30,) dit qu'on le faisait avec du charbon de saule, du salpetre, de l'eau de vie, de la resine, du soufre, de la poix et du camphre. Mais il est probable que nous ne savons pas qu'elle etait sa composition, surtout a cause du secret qu'en faisaient*

les Grecs. En effet, l'empereur Constantin Porphyrogenete recommande a son fils de ne jamais en donner aux Barbares, et de leur repondre, s'ils en demandaient, qu'il avait ete apporté du ciel par un ange et que le secret en avait ete confié aux Chrétiens (Constantini Porphyrogennetae opera, p. 26-27, de admin. imper., cap. 12).]

Of Music (1129. 1130).

1129.

A drum with cogs working by wheels with springs .

[Footnote: This chapter consists of explanations of the sketches shown on Pl. CXXI. Lines 1 and 2 of the text are to be seen at the top at the left hand side of the first sketch of a drum. Lines 3-5 refer to the sketch immediately below this. Line 6 is written as the side of the seventh sketch, and lines 7 and 8 at the side of the eighth. Lines 9-16 are at the bottom in the middle. The remainder of the text is at the side of the drawing at the bottom.]

A square drum of which the parchment may be drawn tight or slackened by the lever *a b* .

A drum for harmony .

A clapper for harmony; that is, three clappers together.

Just as one and the same drum makes a deep or acute sound according as the parchments are more or less tightened, so these parchments variously tightened on one and the same drum will make various sounds .

Keys narrow and close together; (*bicchi*) far apart; these will be right for the trumpet shown above.

a must enter in the place of the ordinary keys which have the ... in the openings of a flute.

1130.

Tymbals to be played like the monochord, or the soft flute.

Here there is to be a cylinder of cane after the manner of clappers with a musical round called a Canon, which is sung in four parts; each singer singing the whole round. Therefore I here make a wheel with 4 teeth so that each tooth takes by itself the part of a singer.

[Footnote: In the original there are some more sketches, to which the text, from line 6, refers. They are studies for a contrivance exactly like the cylinder in our musical boxes.]

1131.

Of decorations.

White and sky-blue cloths, woven in checks to make a decoration.

Cloths with the threads drawn at *a b c d e f g h i k*, to go round the decoration.

XIX. PHILOSOPHICAL MAXIMS. MORALS. POLEMICS AND SPECULATIONS.

Vasari indulges in severe strictures on Leonardo's religious views. He speaks, among other things, of his "capricci nel filosofar delle cose naturali" and says on this point: "Per il che fece nell'animo un concetto sì eretico che e' non si accostava a qualsi voglia religione, stimando per avventura assai più lo esser filosofo che cristiano" (see the first edition of 'Le Vite'). But this accusation on the part of a writer in the days of the Inquisition is not a very serious one — and the less so, since, throughout the manuscripts, we find nothing to support it.

Under the heading of "Philosophical Maxims" I have collected all the passages which can give us a clear comprehension of Leonardo's ideas of the world at large. It is scarcely necessary to observe that there is absolutely nothing in them to lead to the inference that he was an atheist. His views of nature and its laws are no doubt very unlike those of his contemporaries, and have a much closer affinity to those which find general acceptance at the present day. On the other hand, it is obvious from Leonardo's will (see No. 1566) that, in the year before his death, he had professed to adhere to the fundamental doctrines of the Roman Catholic faith, and this evidently from his own personal desire and impulse.

The incredible and demonstrably fictitious legend of Leonardo's death in the arms of Francis the First, is given, with others, by Vasari and further embellished by this odious comment: "Mostrava tuttavia quanto avea offeso Dio e gli uomini del mondo, non avendo operato nell'arte come si conveniva." This last accusation, it may be remarked, is above all evidence of the superficial character of the information which Vasari was in a position to give about Leonardo. It seems to imply that Leonardo was disdainful of diligent labour. With regard to the second, referring to Leonardo's morality and dealings with his fellow men, Vasari himself nullifies it by asserting the very contrary in several passages. A further refutation may be found in the following sentence from the letter in which Melsi, the young Milanese nobleman, announces the Master's death to Leonardo's brothers: Credo siate certificati della morte di Maestro Lionardo fratello vostro, e mio quanto ottimo padre, per la cui morte sarebbe impossibile che io potesse esprimere il dolore che io ho preso; e in

mentre che queste mia membra si sosterranno insieme, io possedero una perpetua infelicità, e meritamente perche sviscerato et ardentissimo amore mi portava giornalmente. E dolto ad ognuno la perdita di tal uomo, quale non e piu in podesta della natura, ecc.

It is true that, in April 1476, we find the names of Leonardo and Verrocchio entered in the “Libro degli Uffiziali di notte e de’ Monasteri” as breaking the laws; but we immediately after find the note “Absoluti cum condizione ut retamburentur” (Tamburini was the name given to the warrant cases of the night police). The acquittal therefore did not exclude the possibility of a repetition of the charge. It was in fact repeated, two months later, and on this occasion the Master and his pupil were again fully acquitted. Verrocchio was at this time forty and Leonardo four-and-twenty. The documents referring to this affair are in the State Archives of Florence; they have been withheld from publication, but it seemed to me desirable to give the reader this brief account of the leading facts of the story, as the vague hints of it, which have recently been made public, may have given to the incident an aspect which it had not in reality, and which it does not deserve.

The passages here classed under the head “Morals” reveal Leonardo to us as a man whose life and conduct were unfailingly governed by lofty principles and aims. He could scarcely have recorded his stern reprobation and unmeasured contempt for men who do nothing useful and strive only for riches, if his own life and ambitions had been such as they have so often been misrepresented.

At a period like that, when superstition still exercised unlimited dominion over the minds not merely of the illiterate crowd, but of the cultivated and learned classes, it was very natural that Leonardo’s views as to Alchemy, Ghosts, Magicians, and the like should be met with stern reprobation whenever and wherever he may have expressed them; this accounts for the argumentative tone of all his utterances on such subjects which I have collected in Subdivision III of this section. To these I have added some passages which throw light on Leonardo’s personal views on the Universe. They are, without exception, characterised by a broad spirit of naturalism of which the principles are more strictly applied in his essays on Astronomy, and still more on Physical Geography.

To avoid repetition, only such notes on Philosophy, Morals and Polemics, have been included in this section as occur as independent texts in the original MSS. Several moral reflections have already been given in Vol. I, in section “Allegorical representations, Mottoes and Emblems”. Others will be found in the following section. Nos. 9 to 12, Vol. I, are also passages of an argumentative character. It did not seem requisite to repeat here these and similar passages,

since their direct connection with the context is far closer in places where they have appeared already, than it would be here.

I.

PHILOSOPHICAL MAXIMS.

Prayers to God (1132. 1133).

1132.

I obey Thee Lord, first for the love I ought, in all reason to bear Thee; secondly for that Thou canst shorten or prolong the lives of men.

1133.

A PRAYER.

Thou, O God, dost sell us all good things at the price of labour.

The powers of Nature (1134-1139).

1134.

O admirable impartiality of Thine, Thou first Mover; Thou hast not permitted that any force should fail of the order or quality of its necessary results.

1135.

Necessity is the mistress and guide of nature.

Necessity is the theme and the inventress, the eternal curb and law of nature.

1136.

In many cases one and the same thing is attracted by two strong forces,

namely Necessity and Potency. Water falls in rain; the earth absorbs it from the necessity for moisture; and the sun evaporates it, not from necessity, but by its power.

1137.

Weight, force and casual impulse, together with resistance, are the four external powers in which all the visible actions of mortals have their being and their end.

1138.

Our body is dependant on heaven and heaven on the Spirit.

1139.

The motive power is the cause of all life.
Psychology (1140-1147).

1140.

And you, O Man, who will discern in this work of mine the wonderful works of Nature, if you think it would be a criminal thing to destroy it, reflect how much more criminal it is to take the life of a man; and if this, his external form, appears to thee marvellously constructed, remember that it is nothing as compared with the soul that dwells in that structure; for that indeed, be it what it may, is a thing divine. Leave it then to dwell in His work at His good will and pleasure, and let not your rage or malice destroy a life — for indeed, he who does not value it, does not himself deserve it [Footnote 19: In MS. II 15a is the note: *chi no stima la vita, non la merita.*].

[Footnote: This text is on the back of the drawings reproduced on Pl. CVII. Compare No. 798, 35 note on p. 111: Compare also No. 837 and 838.]

1141.

The soul can never be corrupted with the corruption of the body,, but is in the

body as it were the air which causes the sound of the organ, where when a pipe bursts, the wind would cease to have any good effect. [Footnote: Compare No. 845.]

1142.

The part always has a tendency to reunite with its whole in order to escape from its imperfection.

The spirit desires to remain with its body, because, without the organic instruments of that body, it can neither act, nor feel anything.

1143.

If any one wishes to see how the soul dwells in its body, let him observe how this body uses its daily habitation; that is to say, if this is devoid of order and confused, the body will be kept in disorder and confusion by its soul.

1144.

Why does the eye see a thing more clearly in dreams than with the imagination being awake?

1145.

The senses are of the earth; Reason, stands apart in contemplation.

[Footnote: Compare No. 842.]

1146.

Every action needs to be prompted by a motive.

To know and to will are two operations of the human mind.

Discerning, judging, deliberating are acts of the human mind.

1147.

All our knowledge has its origin in our preceptions.

Science, its principles and rules (1148 — 1161)

1148.

Science is the observation of things possible, whether present or past; prescience is the knowledge of things which may come to pass, though but slowly.

1149.

Experience, the interpreter between formative nature and the human race, teaches how that nature acts among mortals; and being constrained by necessity cannot act otherwise than as reason, which is its helm, requires her to act.

1150.

Wisdom is the daughter of experience.

1151.

Nature is full of infinite causes that have never occurred in experience.

1152.

Truth was the only daughter of Time.

1153.

Experience never errs; it is only your judgments that err by promising themselves effects such as are not caused by your experiments.

Experience does not err; only your judgments err by expecting from her what is not in her power. Men wrongly complain of Experience; with great abuse they accuse her of leading them astray but they set Experience aside, turning from it with complaints as to our ignorance causing us to be carried away by vain and foolish desires to promise ourselves, in her name, things that are not in her power; saying that she is fallacious. Men are unjust in complaining of innocent

Experience, constantly accusing her of error and of false evidence.

1154.

Instrumental or mechanical science is of all the noblest and the most useful, seeing that by means of this all animated bodies that have movement perform all their actions; and these movements are based on the centre of gravity which is placed in the middle dividing unequal weights, and it has dearth and wealth of muscles and also lever and counterlever.

1155.

OF MECHANICS.

Mechanics are the Paradise of mathematical science, because here we come to the fruits of mathematics. [Footnote: Compare No. 660, 11. 19 — 22 (Vol. I., p. 332). 1156.

Every instrument requires to be made by experience.

1157.

The man who blames the supreme certainty of mathematics feeds on confusion, and can never silence the contradictions of sophistical sciences which lead to an eternal quackery.

1158.

There is no certainty in sciences where one of the mathematical sciences cannot be applied, or which are not in relation with these mathematics.

1159.

Any one who in discussion relies upon authority uses, not his understanding, but rather his memory. Good culture is born of a good disposition; and since the cause is more to be praised than the effect, I will rather praise a good disposition

without culture, than good culture without the disposition.

1160.

Science is the captain, and practice the soldiers.

1161.

**OF THE ERRORS OF THOSE WHO DEPEND ON PRACTICE
WITHOUT SCIENCE.**

Those who fall in love with practice without science are like a sailor who enters a ship without a helm or a compass, and who never can be certain whither he is going.

II.

MORALS.

What is life? (1162. 1163).

1162.

Now you see that the hope and the desire of returning home and to one's former state is like the moth to the light, and that the man who with constant longing awaits with joy each new spring time, each new summer, each new month and new year — deeming that the things he longs for are ever too late in coming — does not perceive that he is longing for his own destruction. But this desire is the very quintessence, the spirit of the elements, which finding itself imprisoned with the soul is ever longing to return from the human body to its giver. And you must know that this same longing is that quintessence, inseparable from nature, and that man is the image of the world.

1163.

O Time! consumer of all things; O envious age! thou dost destroy all things and devour all things with the relentless teeth of years, little by little in a slow death. Helen, when she looked in her mirror, seeing the withered wrinkles made in her face by old age, wept and wondered why she had twice been carried away.

O Time! consumer of all things, and O envious age! by which all things are all devoured.

Death.

1164.

Every evil leaves behind a grief in our memory, except the supreme evil, that is death, which destroys this memory together with life.

How to spend life (1165-1170).

1165.

O sleepers! what a thing is slumber! Sleep resembles death. Ah, why then dost thou not work in such wise as that after death thou mayst retain a resemblance to perfect life, when, during life, thou art in sleep so like to the hapless dead? [Footnote: Compare No. 676, Vol. I. p. 353.]

1166.

One pushes down the other.

By these square-blocks are meant the life and the studies of men.

1167.

The knowledge of past times and of the places on the earth is both an ornament and nutriment to the human mind.

1168.

To lie is so vile, that even if it were in speaking well of godly things it would take off something from God's grace; and Truth is so excellent, that if it praises but small things they become noble.

Beyond a doubt truth bears the same relation to falsehood as light to darkness; and this truth is in itself so excellent that, even when it dwells on humble and lowly matters, it is still infinitely above uncertainty and lies, disguised in high and lofty discourses; because in our minds, even if lying should be their fifth element, this does not prevent that the truth of things is the chief nutriment of superior intellects, though not of wandering wits.

But you who live in dreams are better pleased by the sophistical reasons and frauds of wits in great and uncertain things, than by those reasons which are certain and natural and not so far above us.

1169.

Avoid studies of which the result dies with the worker.

1170.

Men are in error when they lament the flight of time, accusing it of being too swift, and not perceiving that it is sufficient as it passes; but good memory, with which nature has endowed us, causes things long past to seem present.

1171.

Learning acquired in youth arrests the evil of old age; and if you understand that old age has wisdom for its food, you will so conduct yourself in youth that your old age will not lack for nourishment.

1172.

The acquisition of any knowledge is always of use to the intellect, because it may thus drive out useless things and retain the good.

For nothing can be loved or hated unless it is first known.

1173.

As a day well spent procures a happy sleep, so a life well employed procures a happy death.

1174.

The water you touch in a river is the last of that which has passed, and the first of that which is coming. Thus it is with time present.

Life if well spent, is long.

1175.

Just as food eaten without caring for it is turned into loathsome nourishment, so study without a taste for it spoils memory, by retaining nothing which it has taken in.

1176.

Just as eating against one's will is injurious to health, so study without a liking for it spoils the memory, and it retains nothing it takes in.

1177.

On Mount Etna the words freeze in your mouth and you may make ice of them.[Footnote 2: There is no clue to explain this strange sentence.]

Just as iron rusts unless it is used, and water putrifies or, in cold, turns to ice, so our intellect spoils unless it is kept in use.

You do ill if you praise, and still worse if you reprove in a matter you do not understand.

When Fortune comes, seize her in front with a sure hand, because behind she is bald.

1178.

It seems to me that men of coarse and clumsy habits and of small knowledge do not deserve such fine instruments nor so great a variety of natural mechanism as men of speculation and of great knowledge; but merely a sack in which their food may be stowed and whence it may issue, since they cannot be judged to be any thing else than vehicles for food; for it seems to me they have nothing about them of the human species but the voice and the figure, and for all the rest are

much below beasts.

1179.

Some there are who are nothing else than a passage for food and augmentors of excrement and fillers of privies, because through them no other things in the world, nor any good effects are produced, since nothing but full privies results from them.

On foolishness and ignorance (1180 — 1182).

1180.

The greatest deception men suffer is from their own opinions.

1181.

Folly is the shield of shame, as unreadiness is that of poverty glorified.

1182.

Blind ignorance misleads us thus and delights with the results of lascivious joys.

Because it does not know the true light. Because it does not know what is the true light.

Vain splendour takes from us the power of being behold! for its vain splendour we go into the fire, thus blind ignorance does mislead us. That is, blind ignorance so misleads us that ...

O! wretched mortals, open your eyes.

On riches (1183 — 1187).

1183.

That is not riches, which may be lost; virtue is our true good and the true reward of its possessor. That cannot be lost; that never deserts us, but when life leaves us. As to property and external riches, hold them with trembling; they often leave their possessor in contempt, and mocked at for having lost them.

1184.

Every man wishes to make money to give it to the doctors, destroyers of life; they then ought to be rich. [Footnote 2: Compare No. 856.]

Man has much power of discourse which for the most part is vain and false; animals have but little, but it is useful and true, and a small truth is better than a great lie.

1185.

He who possesses most must be most afraid of loss.

1186.

He who wishes to be rich in a day will be hanged in a year.

1187.

That man is of supreme folly who always wants for fear of wanting; and his life flies away while he is still hoping to enjoy the good things which he has with extreme labour acquired.

Rules of Life (1188-1202).

1188.

If you governed your body by the rules of virtue you would not walk on all fours in this world.

You grow in reputation like bread in the hands of a child.

[Footnote: The first sentence is obscure. Compare Nos. 825, 826.]

1189.

Savage he is who saves himself.

1190.

We ought not to desire the impossible. [Footnote: The writing of this note, which is exceedingly minute, is reproduced in facsimile on Pl. XLI No. 5 above the first diagram.

1191.

Ask counsel of him who rules himself well.
Justice requires power, insight, and will; and it resembles the queen-bee.
He who does not punish evil commands it to be done.
He who takes the snake by the tail will presently be bitten by it.
The grave will fall in upon him who digs it.

1192.

The man who does not restrain wantonness, allies himself with beasts.
You can have no dominion greater or less than that over yourself.
He who thinks little, errs much.
It is easier to contend with evil at the first than at the last.
No counsel is more loyal than that given on ships which are in peril: He may expect loss who acts on the advice of an inexperienced youth.

1193.

Where there is most feeling, there is the greatest martyrdom; — a great martyr.

1194.

The memory of benefits is a frail defence against ingratitude.
Reprove your friend in secret and praise him openly.
Be not false about the past.

1195.

A SIMILE FOR PATIENCE.

Patience serves us against insults precisely as clothes do against the cold. For if you multiply your garments as the cold increases, that cold cannot hurt you; in the same way increase your patience under great offences, and they cannot hurt your feelings.

1196.

To speak well of a base man is much the same as speaking ill of a good man.

1197.

Envy wounds with false accusations, that is with detraction, a thing which scares virtue.

1198.

We are deceived by promises and time disappoints us ... [Footnote 2: The rest of this passage may be rendered in various ways, but none of them give a satisfactory meaning.]

1199.

Fear arises sooner than any thing else.

1200.

Just as courage imperils life, fear protects it.

Threats alone are the weapons of the threatened man.

Wherever good fortune enters, envy lays siege to the place and attacks it; and when it departs, sorrow and repentance remain behind.

He who walks straight rarely falls.

It is bad if you praise, and worse if you reprove a thing, I mean, if you do not understand the matter well.

It is ill to praise, and worse to reprimand in matters that you do not understand.

1201.

Words which do not satisfy the ear of the hearer weary him or vex him, and the symptoms of this you will often see in such hearers in their frequent yawns; you therefore, who speak before men whose good will you desire, when you see such an excess of fatigue, abridge your speech, or change your discourse; and if you do otherwise, then instead of the favour you desire, you will get dislike and hostility.

And if you would see in what a man takes pleasure, without hearing him speak, change the subject of your discourse in talking to him, and when you presently see him intent, without yawning or wrinkling his brow or other actions of various kinds, you may be certain that the matter of which you are speaking is such as is agreeable to him &c.

1202.

The lover is moved by the beloved object as the senses are by sensible objects; and they unite and become one and the same thing. The work is the first thing born of this union; if the thing loved is base the lover becomes base.

When the thing taken into union is perfectly adapted to that which receives it, the result is delight and pleasure and satisfaction.

When that which loves is united to the thing beloved it can rest there; when the burden is laid down it finds rest there.

Politics (1203. 1204).

1203.

There will be eternal fame also for the inhabitants of that town, constructed and enlarged by him.

All communities obey and are led by their magnates, and these magnates ally themselves with the lords and subjugate them in two ways: either by consanguinity, or by fortune; by consanguinity, when their children are, as it were, hostages, and a security and pledge of their suspected fidelity; by property, when you make each of these build a house or two inside your city which may yield some revenue and he shall have...; 10 towns, five thousand houses with thirty thousand inhabitants, and you will disperse this great congregation of people which stand like goats one behind the other, filling every place with fetid

smells and sowing seeds of pestilence and death;

And the city will gain beauty worthy of its name and to you it will be useful by its revenues, and the eternal fame of its aggrandizement.

[Footnote: These notes were possibly written in preparation for a letter. The meaning is obscure.]

1204.

To preserve Nature's chiefest boon, that is freedom, I can find means of offence and defence, when it is assailed by ambitious tyrants, and first I will speak of the situation of the walls, and also I shall show how communities can maintain their good and just Lords.

[Footnote: Compare No. 1266.]

III.

POLEMICS. — SPECULATION.

Against Speculators (1205. 1206).

1205.

Oh! speculators on things, boast not of knowing the things that nature ordinarily brings about; but rejoice if you know the end of those things which you yourself devise.

1206.

Oh! speculators on perpetual motion how many vain projects of the like character you have created! Go and be the companions of the searchers for gold.

[Footnote: Another short passage in MS. I, referring also to speculators, is given by LIBRI (*Hist, des Sciences math.* III, 228): *Sicche voi speculatori non vi fidate delli autori che anno sol col imaginatione voluto farsi interpreti tra la natura e l'omo, ma sol di quelli che non coi cienni della natura, ma cogli effetti delle sue esperienze anno esercitati i loro ingegni.*]

Against alchemists (1207. 1208).

1207.

The false interpreters of nature declare that quicksilver is the common seed of every metal, not remembering that nature varies the seed according to the variety of the things she desires to produce in the world.

1208.

And many have made a trade of delusions and false miracles, deceiving the stupid multitude.

Against friars.

1209.

Pharisees — that is to say, friars.

[Footnote: Compare No. 837, 11. 54-57, No. 1296 (p. 363 and 364), and No. 1305 (p. 370).]

Against writers of epitomes.

1210.

Abbreviators do harm to knowledge and to love, seeing that the love of any thing is the offspring of this knowledge, the love being the more fervent in proportion as the knowledge is more certain. And this certainty is born of a complete knowledge of all the parts, which, when combined, compose the totality of the thing which ought to be loved. Of what use then is he who abridges the details of those matters of which he professes to give thorough information, while he leaves behind the chief part of the things of which the whole is composed? It is true that impatience, the mother of stupidity, praises brevity, as if such persons had not life long enough to serve them to acquire a complete knowledge of one single subject, such as the human body; and then they want to comprehend the mind of God in which the universe is included, weighing it minutely and mincing it into infinite parts, as if they had to dissect it!

Oh! human stupidity, do you not perceive that, though you have been with yourself all your life, you are not yet aware of the thing you possess most of, that is of your folly? and then, with the crowd of sophists, you deceive yourselves and others, despising the mathematical sciences, in which truth dwells and the

knowledge of the things included in them. And then you occupy yourself with miracles, and write that you possess information of those things of which the human mind is incapable and which cannot be proved by any instance from nature. And you fancy you have wrought miracles when you spoil a work of some speculative mind, and do not perceive that you are falling into the same error as that of a man who strips a tree of the ornament of its branches covered with leaves mingled with the scented blossoms or fruit..... [Footnote 48: *Givstino*, Marcus Junianus Justinus, a Roman historian of the second century, who compiled an epitome from the general history written by Trogus Pompeius, who lived in the time of Augustus. The work of the latter writer no longer exist.] as Justinus did, in abridging the histories written by Trogus Pompeius, who had written in an ornate style all the worthy deeds of his forefathers, full of the most admirable and ornamental passages; and so composed a bald work worthy only of those impatient spirits, who fancy they are losing as much time as that which they employ usefully in studying the works of nature and the deeds of men. But these may remain in company of beasts; among their associates should be dogs and other animals full of rapine and they may hunt with them after...., and then follow helpless beasts, which in time of great snows come near to your houses asking alms as from their master....

On spirits (1211 — 1213).

1211.

O mathematicians shed light on this error.

The spirit has no voice, because where there is a voice there is a body, and where there is a body space is occupied, and this prevents the eye from seeing what is placed behind that space; hence the surrounding air is filled by the body, that is by its image.

1212.

There can be no voice where there is no motion or percussion of the air; there can be no percussion of the air where there is no instrument, there can be no instrument without a body; and this being so, a spirit can have neither voice, nor form, nor strength. And if it were to assume a body it could not penetrate nor enter where the passages are closed. And if any one should say that by air, compressed and compacted together, a spirit may take bodies of various forms and by this means speak and move with strength — to him I reply that when

there are neither nerves nor bones there can be no force exercised in any kind of movement made by such imaginary spirits.

Beware of the teaching of these speculators, because their reasoning is not confirmed by experience.

1213.

Of all human opinions that is to be reputed the most foolish which deals with the belief in Necromancy, the sister of Alchemy, which gives birth to simple and natural things. But it is all the more worthy of reprehension than alchemy, because it brings forth nothing but what is like itself, that is, lies; this does not happen in Alchemy which deals with simple products of nature and whose function cannot be exercised by nature itself, because it has no organic instruments with which it can work, as men do by means of their hands, who have produced, for instance, glass &c. but this Necromancy the flag and flying banner, blown by the winds, is the guide of the stupid crowd which is constantly witness to the dazzling and endless effects of this art; and there are books full, declaring that enchantments and spirits can work and speak without tongues and without organic instruments — without which it is impossible to speak — and can carry heaviest weights and raise storms and rain; and that men can be turned into cats and wolves and other beasts, although indeed it is those who affirm these things who first became beasts.

And surely if this Necromancy did exist, as is believed by small wits, there is nothing on the earth that would be of so much importance alike for the detriment and service of men, if it were true that there were in such an art a power to disturb the calm serenity of the air, converting it into darkness and making coruscations or winds, with terrific thunder and lightnings rushing through the darkness, and with violent storms overthrowing high buildings and rooting up forests; and thus to oppose armies, crushing and annihilating them; and, besides these frightful storms may deprive the peasants of the reward of their labours. — Now what kind of warfare is there to hurt the enemy so much as to deprive him of the harvest? What naval warfare could be compared with this? I say, the man who has power to command the winds and to make ruinous gales by which any fleet may be submerged, — surely a man who could command such violent forces would be lord of the nations, and no human ingenuity could resist his crushing force. The hidden treasures and gems reposing in the body of the earth would all be made manifest to him. No lock nor fortress, though impregnable, would be able to save any one against the will of the necromancer. He would

have himself carried through the air from East to West and through all the opposite sides of the universe. But why should I enlarge further upon this? What is there that could not be done by such a craftsman? Almost nothing, except to escape death. Hereby I have explained in part the mischief and the usefulness, contained in this art, if it is real; and if it is real why has it not remained among men who desire it so much, having nothing to do with any deity? For I know that there are numberless people who would, to satisfy a whim, destroy God and all the universe; and if this necromancy, being, as it were, so necessary to men, has not been left among them, it can never have existed, nor will it ever exist according to the definition of the spirit, which is invisible in substance; for within the elements there are no incorporate things, because where there is no body, there is a vacuum; and no vacuum can exist in the elements because it would be immediately filled up. Turn over.

1214.

OF SPIRITS.

We have said, on the other side of this page, that the definition of a spirit is a power conjoined to a body; because it cannot move of its own accord, nor can it have any kind of motion in space; and if you were to say that it moves itself, this cannot be within the elements. For, if the spirit is an incorporeal quantity, this quantity is called a vacuum, and a vacuum does not exist in nature; and granting that one were formed, it would be immediately filled up by the rushing in of the element in which the vacuum had been generated. Therefore, from the definition of weight, which is this — Gravity is an accidental power, created by one element being drawn to or suspended in another — it follows that an element, not weighing anything compared with itself, has weight in the element above it and lighter than it; as we see that the parts of water have no gravity or levity compared with other water, but if you draw it up into the air, then it would acquire weight, and if you were to draw the air beneath the water then the water which remains above this air would acquire weight, which weight could not sustain itself by itself, whence collapse is inevitable. And this happens in water; wherever the vacuum may be in this water it will fall in; and this would happen with a spirit amid the elements, where it would continuously generate a vacuum in whatever element it might find itself, whence it would be inevitable that it should be constantly flying towards the sky until it had quitted these elements.

AS TO WHETHER A SPIRIT HAS A BODY AMID THE ELEMENTS.

We have proved that a spirit cannot exist of itself amid the elements without a body, nor can it move of itself by voluntary motion unless it be to rise upwards. But now we will say how such a spirit taking an aerial body would be inevitably melt into air; because if it remained united, it would be separated and fall to form a vacuum, as is said above; therefore it is inevitable, if it is to be able to remain suspended in the air, that it should absorb a certain quantity of air; and if it were mingled with the air, two difficulties arise; that is to say: It must rarefy that portion of the air with which it mingles; and for this cause the rarefied air must fly up of itself and will not remain among the air that is heavier than itself; and besides this the subtle spiritual essence disunites itself, and its nature is modified, by which that nature loses some of its first virtue. Added to these there is a third difficulty, and this is that such a body formed of air assumed by the spirits is exposed to the penetrating winds, which are incessantly sundering and dispersing the united portions of the air, revolving and whirling amidst the rest of the atmosphere; therefore the spirit which is infused in this

1215.

air would be dismembered or rent and broken up with the rending of the air into which it was incorporated.

AS TO WHETHER THE SPIRIT, HAVING TAKEN THIS BODY OF AIR, CAN MOVE OF ITSELF OR NOT.

It is impossible that the spirit infused into a certain quantity of air, should move this air; and this is proved by the above passage where it is said: the spirit rarefies that portion of the air in which it incorporates itself; therefore this air will rise high above the other air and there will be a motion of the air caused by its lightness and not by a voluntary movement of the spirit, and if this air is encountered by the wind, according to the 3rd of this, the air will be moved by the wind and not by the spirit incorporated in it.

AS TO WHETHER THE SPIRIT CAN SPEAK OR NOT.

In order to prove whether the spirit can speak or not, it is necessary in the first place to define what a voice is and how it is generated; and we will say that the voice is, as it were, the movement of air in friction against a dense body, or a dense body in friction against the air, — which is the same thing. And this friction of the dense and the rare condenses the rare and causes resistance; again, the rare, when in swift motion, and the rare in slow motion condense each other when they come in contact and make a noise and very great uproar; and the sound or murmur made by the rare moving through the rare with only moderate swiftness, like a great flame generating noises in the air; and the tremendous uproar made by the rare mingling with the rare, and when that air which is both swift and rare rushes into that which is itself rare and in motion, it is like the flame of fire which issues from a big gun and striking against the air; and again when a flame issues from the cloud, there is a concussion in the air as the bolt is generated. Therefore we may say that the spirit cannot produce a voice without movement of the air, and air in it there is none, nor can it emit what it has not; and if desires to move that air in which it is incorporated, it is necessary that the spirit should multiply itself, and that cannot multiply which has no quantity. And in the 4th place it is said that no rare body can move, if it has not a stable spot, whence it may take its motion; much more is it so when an element has to move within its own element, which does not move of itself, excepting by uniform evaporation at the centre of the thing evaporated; as occurs in a sponge squeezed in the hand held under water; the water escapes in every direction with equal movement through the openings between the fingers of the hand in which it is squeezed.

As to whether the spirit has an articulate voice, and whether the spirit can be heard, and what hearing is, and seeing; the wave of the voice passes through the air as the images of objects pass to the eye.

Nonentity.

1216.

Every quantity is intellectually conceivable as infinitely divisible.

[Amid the vastness of the things among which we live, the existence of nothingness holds the first place; its function extends over all things that have no existence, and its essence, as regards time, lies precisely between the past and the future, and has nothing in the present. This nothingness has the part equal to

the whole, and the whole to the part, the divisible to the indivisible; and the product of the sum is the same whether we divide or multiply, and in addition as in subtraction; as is proved by arithmeticians by their tenth figure which represents zero; and its power has not extension among the things of Nature.]

[What is called Nothingness is to be found only in time and in speech. In time it stands between the past and future and has no existence in the present; and thus in speech it is one of the things of which we say: They are not, or they are impossible.]

With regard to time, nothingness lies between the past and the future, and has nothing to do with the present, and as to its nature it is to be classed among things impossible: hence, from what has been said, it has no existence; because where there is nothing there would necessarily be a vacuum.

[Footnote: Compare No. 916.]

Reflections on Nature (1217-1219).

1217.

EXAMPLE OF THE LIGHTNING IN CLOUDS.

[O mighty and once living instrument of formative nature. Incapable of availing thyself of thy vast strength thou hast to abandon a life of stillness and to obey the law which God and time gave to procreative nature.]

Ah! how many a time the shoals of terrified dolphins and the huge tunny-fish were seen to flee before thy cruel fury, to escape; whilst thy fulminations raised in the sea a sudden tempest with buffeting and submersion of ships in the great waves; and filling the uncovered shores with the terrified and desperate fishes which fled from thee, and left by the sea, remained in spots where they became the abundant prey of the people in the neighbourhood.

O time, swift robber of all created things, how many kings, how many nations hast thou undone, and how many changes of states and of various events have happened since the wondrous forms of this fish perished here in this cavernous and winding recess. Now destroyed by time thou liest patiently in this confined space with bones stripped and bare; serving as a support and prop for the superimposed mountain.

[Footnote: The character of the handwriting points to an early period of Leonardo's life. It has become very indistinct, and is at present exceedingly difficult to decipher. Some passages remain doubtful.]

[Footnote: Compare No. 1339, written on the same sheet.]

1218.

The watery element was left enclosed between the raised banks of the rivers, and the sea was seen between the uplifted earth and the surrounding air which has to envelope and enclose the complicated machine of the earth, and whose mass, standing between the water and the element of fire, remained much restricted and deprived of its indispensable moisture; the rivers will be deprived of their waters, the fruitful earth will put forth no more her light verdure; the fields will no more be decked with waving corn; all the animals, finding no fresh grass for pasture, will die and food will then be lacking to the lions and wolves and other beasts of prey, and to men who after many efforts will be compelled to abandon their life, and the human race will die out. In this way the fertile and fruitful earth will remain deserted, arid and sterile from the water being shut up in its interior, and from the activity of nature it will continue a little time to increase until the cold and subtle air being gone, it will be forced to end with the element of fire; and then its surface will be left burnt up to cinder and this will be the end of all terrestrial nature. [Footnote: Compare No. 1339, written on the same sheet.]

1219.

Why did nature not ordain that one animal should not live by the death of another? Nature, being inconstant and taking pleasure in creating and making constantly new lives and forms, because she knows that her terrestrial materials become thereby augmented, is more ready and more swift in her creating, than time in his destruction; and so she has ordained that many animals shall be food for others. Nay, this not satisfying her desire, to the same end she frequently sends forth certain poisonous and pestilential vapours upon the vast increase and congregation of animals; and most of all upon men, who increase vastly because other animals do not feed upon them; and, the causes being removed, the effects would not follow. This earth therefore seeks to lose its life, desiring only continual reproduction; and as, by the argument you bring forward and demonstrate, like effects always follow like causes, animals are the image of the world.

XX. HUMOROUS WRITINGS.

Just as Michaelangelo's occasional poems reflect his private life as well as the general disposition of his mind, we may find in the writings collected in this section, the transcript of Leonardo's fanciful nature, and we should probably not be far wrong in assuming, that he himself had recited these fables in the company of his friends or at the court festivals of princes and patrons. Era tanto piacevole nella conversazione — so relates Vasari — che tirava a se gli animi delle genti. And Paulus Jovius says in his short biography of the artist: Fuit ingenio valde comi, nitido, liberali, vultu autem longe venustissimo, et cum elegantiae omnis deliciarumque maxime theatralium mirificus inventor ac arbiter esset, ad lyramque scito caneret, cunctis per omnem aetatem principibus mire placuit. There can be no doubt that the fables are the original offspring of Leonardo's brain, and not borrowed from any foreign source; indeed the schemes and plans for the composition of fables collected in division V seem to afford an external proof of this, if the fables themselves did not render it self-evident. Several of them — for instance No. 1279 — are so strikingly characteristic of Leonardo's views of natural science that we cannot do them justice till we are acquainted with his theories on such subjects; and this is equally true of the 'Prophecies'.

I have prefixed to these quaint writings the 'Studies on the life and habits of animals' which are singular from their peculiar aphoristic style, and I have transcribed them in exactly the order in which they are written in MS. H. This is one of the very rare instances in which one subject is treated in a consecutive series of notes, all in one MS., and Leonardo has also departed from his ordinary habits, by occasionally not completing the text on the page it is begun. These brief notes of a somewhat mysterious bearing have been placed here, simply because they may possibly have been intended to serve as hints for fables or allegories. They can scarcely be regarded as preparatory for a natural history, rather they would seem to be extracts. On the one hand the names of some of the animals seem to prove that Leonardo could not here be recording observations of his own; on the other hand the notes on their habits and life appear to me to dwell precisely on what must have interested him most — so far as it is possible to form any complete estimate of his nature and tastes.

In No. 1293 lines 1-10, we have a sketch of a scheme for grouping the Prophecies. I have not however availed myself of it as a clue to their

arrangement here because, in the first place, the texts are not so numerous as to render the suggested classification useful to the reader, and, also, because in reading the long series, as they occur in the original, we may follow the author's mind; and here and there it is not difficult to see how one theme suggested another. I have however regarded Leonardo's scheme for the classification of the Prophecies as available for that of the Fables and Jests, and have adhered to it as far as possible.

Among the humorous writings I might perhaps have included the 'Rebusses', of which there are several in the collection of Leonardo's drawings at Windsor; it seems to me not likely that many or all of them could be solved at the present day and the MSS. throw no light on them. Nor should I be justified if I intended to include in the literary works the well-known caricatures of human faces attributed to Leonardo — of which, however, it may be incidentally observed, the greater number are in my opinion undoubtedly spurious. Two only have necessarily been given owing to their presence in text, which it was desired to reproduce: Vol. I page 326, and Pl. CXXII. It can scarcely be doubted that some satirical intention is conveyed by the drawing on Pl. LXIV (text No. 688).

My reason for not presenting Leonardo to the reader as a poet is the fact that the maxims and morals in verse which have been ascribed to him, are not to be found in the manuscripts, and Prof. Uzielli has already proved that they cannot be by him. Hence it would seem that only a few short verses can be attributed to him with any certainty.

I.

STUDIES ON THE LIFE AND HABITS OF ANIMALS.

1220.

THE LOVE OF VIRTUE.

The goldfinch is a bird of which it is related that, when it is carried into the presence of a sick person, if the sick man is going to die, the bird turns away its head and never looks at him; but if the sick man is to be saved the bird never loses sight of him but is the cause of curing him of all his sickness.

Like unto this is the love of virtue. It never looks at any vile or base thing, but rather clings always to pure and virtuous things and takes up its abode in a noble heart; as the birds do in green woods on flowery branches. And this Love shows itself more in adversity than in prosperity; as light does, which shines most where the place is darkest.

1221.

ENVY.

We read of the kite that, when it sees its young ones growing too big in the nest, out of envy it pecks their sides, and keeps them without food.

CHEERFULNESS.

Cheerfulness is proper to the cock, which rejoices over every little thing, and crows with varied and lively movements.

SADNESS.

Sadness resembles the raven, which, when it sees its young ones born white, departs in great grief, and abandons them with doleful lamentations, and does not feed them until it sees in them some few black feathers.

1222.

PEACE.

We read of the beaver that when it is pursued, knowing that it is for the virtue [contained] in its medicinal testicles and not being able to escape, it stops; and to be at peace with its pursuers, it bites off its testicles with its sharp teeth, and leaves them to its enemies.

RAGE.

It is said of the bear that when it goes to the haunts of bees to take their honey, the bees having begun to sting him he leaves the honey and rushes to revenge himself. And as he seeks to be revenged on all those that sting him, he is revenged on none; in such wise that his rage is turned to madness, and he flings himself on the ground, vainly exasperating, by his hands and feet, the foes against which he is defending himself.

1223.

GRATITUDE.

The virtue of gratitude is said to be more [developed] in the birds called hoopoes which, knowing the benefits of life and food, they have received from their father and their mother, when they see them grow old, make a nest for them and brood over them and feed them, and with their beaks pull out their old and shabby feathers; and then, with a certain herb restore their sight so that they return to a prosperous state.

AVARICE.

The toad feeds on earth and always remains lean; because it never eats enough: — it is so afraid lest it should want for earth.

1224.

INGRATITUDE.

Pigeons are a symbol of ingratitude; for when they are old enough no longer to need to be fed, they begin to fight with their father, and this struggle does not end until the young one drives the father out and takes the hen and makes her his own.

CRUELTY.

The basilisk is so utterly cruel that when it cannot kill animals by its baleful gaze, it turns upon herbs and plants, and fixing its gaze on them withers them up.

1225.

GENEROSITY.

It is said of the eagle that it is never so hungry but that it will leave a part of its prey for the birds that are round it, which, being unable to provide their own food, are necessarily dependent on the eagle, since it is thus that they obtain food.

DISCIPLINE.

When the wolf goes cunningly round some stable of cattle, and by accident puts his foot in a trap, so that he makes a noise, he bites his foot off to punish himself for his folly.

1226.

FLATTERERS OR SYRENS.

The syren sings so sweetly that she lulls the mariners to sleep; then she climbs upon the ships and kills the sleeping mariners.

PRUDENCE.

The ant, by her natural foresight provides in the summer for the winter, killing the seeds she harvests that they may not germinate, and on them, in due time she feeds.

FOLLY.

The wild bull having a horror of a red colour, the hunters dress up the trunk of a tree with red and the bull runs at this with great frenzy, thus fixing his horns, and forthwith the hunters kill him there.

1227.

JUSTICE.

We may liken the virtue of Justice to the king of the bees which orders and arranges every thing with judgment. For some bees are ordered to go to the flowers, others are ordered to labour, others to fight with the wasps, others to clear away all dirt, others to accompany and escort the king; and when he is old and has no wings they carry him. And if one of them fails in his duty, he is punished without reprieve.

TRUTH.

Although partridges steal each other's eggs, nevertheless the young born of these eggs always return to their true mother.

1228.

FIDELITY, OR LOYALTY.

The cranes are so faithful and loyal to their king, that at night, when he is sleeping, some of them go round the field to keep watch at a distance; others remain near, each holding a stone in his foot, so that if sleep should overcome them, this stone would fall and make so much noise that they would wake up again. And there are others which sleep together round the king; and this they do every night, changing in turn so that their king may never find them wanting.

FALSEHOOD.

The fox when it sees a flock of herons or magpies or birds of that kind, suddenly flings himself on the ground with his mouth open to look as he were dead; and these birds want to peck at his tongue, and he bites off their heads.

1229.

LIES.

The mole has very small eyes and it always lives under ground; and it lives as long as it is in the dark but when it comes into the light it dies immediately, because it becomes known; — and so it is with lies.

VALOUR.

The lion is never afraid, but rather fights with a bold spirit and savage onslaught against a multitude of hunters, always seeking to injure the first that injures him.

FEAR OR COWARDICE.

The hare is always frightened; and the leaves that fall from the trees in autumn always keep him in terror and generally put him to flight.

1230.

MAGNANIMITY.

The falcon never preys but on large birds; and it will let itself die rather than feed on little ones, or eat stinking meat.

VAIN GLORY.

As regards this vice, we read that the peacock is more guilty of it than any other animal. For it is always contemplating the beauty of its tail, which it spreads in the form of a wheel, and by its cries attracts to itself the gaze of the creatures that surround it.

And this is the last vice to be conquered.

1231.

CONSTANCY.

Constancy may be symbolised by the phoenix which, knowing that by nature it must be resuscitated, has the constancy to endure the burning flames which consume it, and then it rises anew.

INCONSTANCY.

The swallow may serve for Inconstancy, for it is always in movement, since it cannot endure the smallest discomfort.

CONTINENCE.

The camel is the most lustful animal there is, and will follow the female for a thousand miles. But if you keep it constantly with its mother or sister it will leave them alone, so temperate is its nature.

1232.

INCONTINENCE.

The unicorn, through its intemperance and not knowing how to control itself, for the love it bears to fair maidens forgets its ferocity and wildness; and laying

aside all fear it will go up to a seated damsel and go to sleep in her lap, and thus the hunters take it.

HUMILITY.

We see the most striking example of humility in the lamb which will submit to any animal; and when they are given for food to imprisoned lions they are as gentle to them as to their own mother, so that very often it has been seen that the lions forbear to kill them.

1233.

PRIDE.

The falcon, by reason of its haughtiness and pride, is fain to lord it and rule over all the other birds of prey, and longs to be sole and supreme; and very often the falcon has been seen to assault the eagle, the Queen of birds.

ABSTINENCE.

The wild ass, when it goes to the well to drink, and finds the water troubled, is never so thirsty but that it will abstain from drinking, and wait till the water is clear again.

GLUTTONY.

The vulture is so addicted to gluttony that it will go a thousand miles to eat a carrion [carcase]; therefore is it that it follows armies.

1234.

CHASTITY.

The turtle-dove is never false to its mate; and if one dies the other preserves perpetual chastity, and never again sits on a green bough, nor ever again drinks of clear water.

UNCHASTITY.

The bat, owing to unbridled lust, observes no universal rule in pairing, but males with males and females with females pair promiscuously, as it may happen.

MODERATION.

The ermine out of moderation never eats but once in the day; it will rather let itself be taken by the hunters than take refuge in a dirty lair, in order not to stain its purity.

1235.

THE EAGLE.

The eagle when it is old flies so high that it scorches its feathers, and Nature allowing that it should renew its youth, it falls into shallow water [Footnote 5: The meaning is obscure.]. And if its young ones cannot bear to gaze on the sun [Footnote 6: The meaning is obscure.] — ; it does not feed them with any bird, that does not wish to die. Animals which much fear it do not approach its nest, although it does not hurt them. It always leaves part of its prey uneaten.

LUMERPA, — FAME.

This is found in Asia Major, and shines so brightly that it absorbs its own shadow, and when it dies it does not lose this light, and its feathers never fall out, but a feather pulled out shines no longer.

1236.

THE PELICAN.

This bird has a great love for its young; and when it finds them in its nest dead from a serpent's bite, it pierces itself to the heart, and with its blood it bathes them till they return to life.

THE SALAMANDER.

This has no digestive organs, and gets no food but from the fire, in which it constantly renews its scaly skin.

The salamander, which renews its scaly skin in the fire, — for virtue.

THE CAMELEON.

This lives on air, and there it is the prey of all the birds; so in order to be safer it flies above the clouds and finds an air so rarefied that it cannot support the bird that follows it.

At that height nothing can go unless it has a gift from Heaven, and that is where the chameleon flies.

1237.

THE ALEPO, A FISH.

The fish *alepo* does not live out of water.

THE OSTRICH.

This bird converts iron into nourishment, and hatches its eggs by its gaze; — Armies under commanders.

THE SWAN.

The swan is white without any spot, and it sings sweetly as it dies, its life ending with that song.

THE STORK.

This bird, by drinking saltwater purges itself of distempers. If the male finds his mate unfaithful, he abandons her; and when it grows old its young ones brood over it, and feed it till it dies.

1238.

THE GRASSHOPPER.

This silences the cuckoo with its song. It dies in oil and revives in vinegar. It sings in the greatest heats

THE BAT.

The more light there is the blinder this creature becomes; as those who gaze most at the sun become most dazzled. — For Vice, that cannot remain where Virtue appears.

THE PARTRIDGE.

This bird changes from the female into the male and forgets its former sex; and out of envy it steals the eggs from others and hatches them, but the young ones follow the true mother.

THE SWALLOW.

This bird gives sight to its blind young ones by means of celandine.

1239.

THE OYSTER. — FOR TREACHERY.

This creature, when the moon is full opens itself wide, and when the crab looks in he throws in a piece of rock or seaweed and the oyster cannot close again, whereby it serves for food to that crab. This is what happens to him who opens his mouth to tell his secret. He becomes the prey of the treacherous hearer.

THE BASILISK. — CRUELTY.

All snakes flie from this creature; but the weasel attacks it by means of rue and kills it.

THE ASP.

This carries instantaneous death in its fangs; and, that it may not hear the charmer it stops its ears with its tail.

1240.

THE DRAGON.

This creature entangles itself in the legs of the elephant which falls upon it, and so both die, and in its death it is avenged.

THE VIPER.

She, in pairing opens her mouth and at last clenches her teeth and kills her husband. Then the young ones, growing within her body rend her open and kill their mother.

THE SCORPION.

Saliva, spit out when fasting will kill a scorpion. This may be likened to abstinence from greediness, which removes and heals the ills which result from that gluttony, and opens the path of virtue.

1241.

THE CROCODILE. HYPOCRISY.

This animal catches a man and straightway kills him; after he is dead, it weeps for him with a lamentable voice and many tears. Then, having done lamenting, it cruelly devours him. It is thus with the hypocrite, who, for the smallest matter, has his face bathed with tears, but shows the heart of a tiger and rejoices in his heart at the woes of others, while wearing a pitiful face.

THE TOAD.

The toad flies from the light of the sun, and if it is held there by force it puffs itself out so much as to hide its head below and shield itself from the rays. Thus does the foe of clear and radiant virtue, who can only be constrainedly brought to face it with puffed up courage.

1242.

THE CATERPILLAR. — FOR VIRTUE IN GENERAL.

The caterpillar, which by means of assiduous care is able to weave round itself a new dwelling place with marvellous artifice and fine workmanship, comes out of it afterwards with painted and lovely wings, with which it rises towards Heaven.

THE SPIDER.

The spider brings forth out of herself the delicate and ingenious web, which makes her a return by the prey it takes.

[Footnote: Two notes are underneath this text. The first: '*nessuna chosa e da ttemere piu che lla sozza fama*' is a repetition of the first line of the text given in Vol. I No. 695.

The second: *faticha fugga cholla fama in braccio quasi ochultata c* is written in red chalk and is evidently an incomplete sentence.]

1243.

THE LION.

This animal, with his thundering roar, rouses his young the third day after they are born, teaching them the use of all their dormant senses and all the wild things which are in the wood flee away.

This may be compared to the children of Virtue who are roused by the sound of praise and grow up in honourable studies, by which they are more and more elevated; while all that is base flies at the sound, shunning those who are virtuous.

Again, the lion covers over its foot tracks, so that the way it has gone may not be known to its enemies. Thus it beseems a captain to conceal the secrets of his mind so that the enemy may not know his purpose.

1244.

THE TARANTULA.

The bite of the tarantula fixes a man's mind on one idea; that is on the thing he was thinking of when he was bitten.

THE SCREECH-OWL AND THE OWL.

These punish those who are scoffing at them by pecking out their eyes; for nature has so ordered it, that they may thus be fed.

1245.

THE ELEPHANT.

The huge elephant has by nature what is rarely found in man; that is Honesty, Prudence, Justice, and the Observance of Religion; inasmuch as when the moon is new, these beasts go down to the rivers, and there, solemnly cleansing themselves, they bathe, and so, having saluted the planet, return to the woods. And when they are ill, being laid down, they fling up plants towards Heaven as though they would offer sacrifice. — They bury their tusks when they fall out from old age. — Of these two tusks they use one to dig up roots for food; but they save the point of the other for fighting with; when they are taken by hunters and when worn out by fatigue, they dig up these buried tusks and ransom themselves.

1246.

They are merciful, and know the dangers, and if one finds a man alone and lost, he kindly puts him back in the road he has missed, if he finds the footprints of the man before the man himself. It dreads betrayal, so it stops and blows, pointing it out to the other elephants who form in a troop and go warily.

These beasts always go in troops, and the oldest goes in front and the second in age remains the last, and thus they enclose the troop. Out of shame they pair only at night and secretly, nor do they then rejoin the herd but first bathe in the river. The females do not fight as with other animals; and it is so merciful that it is most unwilling by nature ever to hurt those weaker than itself. And if it meets in the middle of its way a flock of sheep

1247.

it puts them aside with its trunk, so as not to trample them under foot; and it never hurts any thing unless when provoked. When one has fallen into a pit the others fill up the pit with branches, earth and stones, thus raising the bottom that he may easily get out. They greatly dread the noise of swine and fly in confusion, doing no less harm then, with their feet, to their own kind than to the enemy. They delight in rivers and are always wandering about near them, though

on account of their great weight they cannot swim. They devour stones, and the trunks of trees are their favourite food. They have a horror of rats. Flies delight in their smell and settle on their back, and the beast scrapes its skin making its folds even and kills them.

1248.

When they cross rivers they send their young ones up against the stream of the water; thus, being set towards the fall, they break the united current of the water so that the current does not carry them away. The dragon flings itself under the elephant's body, and with its tail it ties its legs; with its wings and with its arms it also clings round its ribs and cuts its throat with its teeth, and the elephant falls upon it and the dragon is burst. Thus, in its death it is revenged on its foe.

THE DRAGON.

These go in companies together, and they twine themselves after the manner of roots, and with their heads raised they cross lakes, and swim to where they find better pasture; and if they did not thus combine

1249.

they would be drowned, therefore they combine.

THE SERPENT.

The serpent is a very large animal. When it sees a bird in the air it draws in its breath so strongly that it draws the birds into its mouth too. Marcus Regulus, the consul of the Roman army was attacked, with his army, by such an animal and almost defeated. And this animal, being killed by a catapult, measured 123 feet, that is 64 1/2 braccia and its head was high above all the trees in a wood.

THE BOA(?)

This is a very large snake which entangles itself round the legs of the cow so that it cannot move and then sucks it, in such wise that it almost dries it up. In the time of Claudius the Emperor, there was killed, on the Vatican Hill,

1250.

one which had inside it a boy, entire, that it had swallowed.

THE MACLI. — CAUGHT WHEN ASLEEP.

This beast is born in Scandinavia. It has the shape of a great horse, excepting that the great length of its neck and of its ears make a difference. It feeds on grass, going backwards, for it has so long an upper lip that if it went forwards it would cover up the grass. Its legs are all in one piece; for this reason when it wants to sleep it leans against a tree, and the hunters, spying out the place where it is wont to sleep, saw the tree almost through, and then, when it leans against it to sleep, in its sleep it falls, and thus the hunters take it. And every other mode of taking it is in vain, because it is incredibly swift in running.

1251.

THE BISON WHICH DOES INJURY IN ITS FLIGHT.

This beast is a native of Paeonia and has a neck with a mane like a horse. In all its other parts it is like a bull, excepting that its horns are in a way bent inwards so that it cannot butt; hence it has no safety but in flight, in which it flings out its excrement to a distance of 400 braccia in its course, and this burns like fire wherever it touches.

LIONS, PARDS, PANTHERS, TIGERS.

These keep their claws in the sheath, and never put them out unless they are on the back of their prey or their enemy.

THE LIONESS.

When the lioness defends her young from the hand of the hunter, in order not to

be frightened by the spears she keeps her eyes on the ground, to the end that she may not by her flight leave her young ones prisoners.

1252.

THE LION.

This animal, which is so terrible, fears nothing more than the noise of empty carts, and likewise the crowing of cocks. And it is much terrified at the sight of one, and looks at its comb with a frightened aspect, and is strangely alarmed when its face is covered.

THE PANTHER IN AFRICA.

This has the form of the lioness but it is taller on its legs and slimmer and long bodied; and it is all white and marked with black spots after the manner of rosettes; and all animals delight to look upon these rosettes, and they would always be standing round it if it were not for the terror of its face;

1253.

therefore knowing this, it hides its face, and the surrounding animals grow bold and come close, the better to enjoy the sight of so much beauty; when suddenly it seizes the nearest and at once devours it.

CAMELS.

The Bactrian have two humps; the Arabian one only. They are swift in battle and most useful to carry burdens. This animal is extremely observant of rule and measure, for it will not move if it has a greater weight than it is used to, and if it is taken too far it does the same, and suddenly stops and so the merchants are obliged to lodge there.

1254.

THE TIGER.

This beast is a native of Hyrcania, and it is something like the panther from the various spots on its skin. It is an animal of terrible swiftness; the hunter when he finds its young ones carries them off hastily, placing mirrors in the place whence he takes them, and at once escapes on a swift horse. The panther returning finds the mirrors fixed on the ground and looking into them believes it sees its young; then scratching with its paws it discovers the cheat. Forthwith, by means of the scent of its young, it follows the hunter, and when this hunter sees the tigress he drops one of the young ones and she takes it, and having carried it to the den she immediately returns to the hunter and does

1255.

the same till he gets into his boat.

CATOBLEPAS.

It is found in Ethiopia near to the source Nigricapo. It is not a very large animal, is sluggish in all its parts, and its head is so large that it carries it with difficulty, in such wise that it always droops towards the ground; otherwise it would be a great pest to man, for any one on whom it fixes its eyes dies immediately. [Footnote: Leonardo undoubtedly derived these remarks as to the Catoblepas from Pliny, Hist. Nat. VIII. 21 (al. 32): *Apud Hesperios Aethiopus fons est Nigris* (different readings), *ut plerique existimavere, Nili caput.* — *-Juxta hunc fera appellatur catoblepas, modica alioquin, ceterisque membris iners, caput tantum praegrave aegre ferens; alias internecio humani generis, omnibus qui oculos ejus videre, confestim morientibus.* Aelian, *Hist. An.* gives a far more minute description of the creature, but he says that it poisons beasts not by its gaze, but by its venomous breath. Athenaeus 221 B, mentions both. If Leonardo had known of these two passages, he would scarcely have omitted the poisonous breath. (H. MULLER-STRUBING.)]

THE BASILISK.

This is found in the province of Cyrenaica and is not more than 12 fingers long. It has on its head a white spot after the fashion of a diadem. It scares all serpents with its whistling. It resembles a snake, but does not move by wriggling but from the centre forwards to the right. It is said that one

1256.

of these, being killed with a spear by one who was on horseback, and its venom flowing on the spear, not only the man but the horse also died. It spoils the wheat and not only that which it touches, but where it breathes the grass dries and the stones are split.

THE WEASEL.

This beast finding the lair of the basilisk kills it with the smell of its urine, and this smell, indeed, often kills the weasel itself.

THE CERASTES.

This has four movable little horns; so, when it wants to feed, it hides under leaves all of its body except these little horns which, as they move, seem to the birds to be some small worms at play. Then they immediately swoop down to pick them and the Cerastes suddenly twines round them and encircles and devours them.

1257.

THE AMPHISBOENA.

This has two heads, one in its proper place the other at the tail; as if one place were not enough from which to fling its venom.

THE IACULUS.

This lies on trees, and flings itself down like a dart, and pierces through the wild beast and kills them.

THE ASP.

The bite of this animal cannot be cured unless by immediately cutting out the bitten part. This pestilential animal has such a love for its mate that they always go in company. And if, by mishap, one of them is killed the other, with incredible swiftness, follows him who has killed it; and it is so determined and eager for vengeance that it overcomes every difficulty, and passing by every troop it seeks to hurt none but its enemy. And it will travel any distance, and it is impossible to avoid it unless by crossing water and by very swift flight. It has its eyes turned inwards, and large ears and it hears better than it sees.

1258.

THE ICHNEUMON.

This animal is the mortal enemy of the asp. It is a native of Egypt and when it sees an asp near its place, it runs at once to the bed or mud of the Nile and with this makes itself muddy all over, then it dries itself in the sun, smears itself again with mud, and thus, drying one after the other, it makes itself three or four coatings like a coat of mail. Then it attacks the asp, and fights well with him, so that, taking its time it catches him in the throat and destroys him.

THE CROCODILE.

This is found in the Nile, it has four feet and lives on land and in water. No other terrestrial creature but this is found to have no tongue, and it only bites by moving its upper jaw. It grows to a length of forty feet and has claws and is armed with a hide that will take any blow. By day it is on land and at night in the water. It feeds on fishes, and going to sleep on the bank of the Nile with its mouth open, a bird called

1259.

trochilus, a very small bird, runs at once to its mouth and hops among its teeth and goes pecking out the remains of the food, and so inciting it with voluptuous delight tempts it to open the whole of its mouth, and so it sleeps. This being observed by the ichneumon it flings itself into its mouth and perforates its

stomach and bowels, and finally kills it.

THE DOLPHIN.

Nature has given such knowledge to animals, that besides the consciousness of their own advantages they know the disadvantages of their foes. Thus the dolphin understands what strength lies in a cut from the fins placed on his chine, and how tender is the belly of the crocodile; hence in fighting with him it thrusts at him from beneath and rips up his belly and so kills him.

The crocodile is a terror to those that flee, and a base coward to those that pursue him.

1260.

THE HIPPOPOTAMUS.

This beast when it feels itself over-full goes about seeking thorns, or where there may be the remains of canes that have been split, and it rubs against them till a vein is opened; then when the blood has flowed as much as he needs, he plasters himself with mud and heals the wound. In form he is something like a horse with long haunches, a twisted tail and the teeth of a wild boar, his neck has a mane; the skin cannot be pierced, unless when he is bathing; he feeds on plants in the fields and goes into them backwards so that it may seem, as though he had come out.

THE IBIS.

This bird resembles a crane, and when it feels itself ill it fills its craw with water, and with its beak makes an injection of it.

THE STAG.

These creatures when they feel themselves bitten by the spider called father-long-legs, eat crabs and free themselves of the venom.

1261.

THE LIZARD.

This, when fighting with serpents eats the sow-thistle and is free.

THE SWALLOW.

This [bird] gives sight to its blind young ones, with the juice of the celandine.

THE WEASEL.

This, when chasing rats first eats of rue.

THE WILD BOAR.

This beast cures its sickness by eating of ivy.

THE SNAKE.

This creature when it wants to renew itself casts its old skin, beginning with the head, and changing in one day and one night.

THE PANTHER.

This beast after its bowels have fallen out will still fight with the dogs and hunters.

1262.

THE CHAMELEON.

This creature always takes the colour of the thing on which it is resting, whence it is often devoured together with the leaves on which the elephant feeds.

THE RAVEN.

When it has killed the Chameleon it takes laurel as a purge.

1263.

Moderation checks all the vices. The ermine will die rather than besmirch itself.

OF FORESIGHT.

The cock does not crow till it has thrice flapped its wings; the parrot in moving among boughs never puts its feet excepting where it has first put its beak. Vows are not made till Hope is dead.

Motion tends towards the centre of gravity.

1264.

MAGNANIMITY.

The falcon never seizes any but large birds and will sooner die than eat [tainted] meat of bad savour.

II.

FABLES.

Fables on animals (1265-1270).

1265.

A FABLE.

An oyster being turned out together with other fish in the house of a fisherman near the sea, he entreated a rat to take him to the sea. The rat purposing to eat him bid him open; but as he bit him the oyster squeezed his head and closed; and the cat came and killed him.

1266.

A FABLE.

The thrushes rejoiced greatly at seeing a man take the owl and deprive her of liberty, tying her feet with strong bonds. But this owl was afterwards by means of bird-lime the cause of the thrushes losing not only their liberty, but their life. This is said for those countries which rejoice in seeing their governors lose their liberty, when by that means they themselves lose all succour, and remain in bondage in the power of their enemies, losing their liberty and often their life.

1267.

A FABLE.

A dog, lying asleep on the fur of a sheep, one of his fleas, perceiving the odour of the greasy wool, judged that this must be a land of better living, and also more secure from the teeth and nails of the dog than where he fed on the dog; and without farther reflection he left the dog and went into the thick wool. There he began with great labour to try to pass among the roots of the hairs; but after much sweating had to give up the task as vain, because these hairs were so close that they almost touched each other, and there was no space where fleas could taste the skin. Hence, after much labour and fatigue, he began to wish to return to his dog, who however had already departed; so he was constrained after long

repentance and bitter tears, to die of hunger.

1268.

A FABLE.

The vain and wandering butterfly, not content with being able to fly at its ease through the air, overcome by the tempting flame of the candle, decided to fly into it; but its sportive impulse was the cause of a sudden fall, for its delicate wings were burnt in the flame. And the hapless butterfly having dropped, all scorched, at the foot of the candlestick, after much lamentation and repentance, dried the tears from its swimming eyes, and raising its face exclaimed: O false light! how many must thou have miserably deceived in the past, like me; or if I must indeed see light so near, ought I not to have known the sun from the false glare of dirty tallow?

A FABLE.

The monkey, finding a nest of small birds, went up to it greatly delighted. But they, being already fledged, he could only succeed in taking the smallest; greatly delighted he took it in his hand and went to his abode; and having begun to look at the little bird he took to kissing it, and from excess of love he kissed it so much and turned it about and squeezed it till he killed it. This is said for those who by not punishing their children let them come to mischief.

1269.

A FABLE.

A rat was besieged in his little dwelling by a weasel, which with unwearied vigilance awaited his surrender, while watching his imminent peril through a little hole. Meanwhile the cat came by and suddenly seized the weasel and forthwith devoured it. Then the rat offered up a sacrifice to Jove of some of his store of nuts, humbly thanking His providence, and came out of his hole to enjoy

his lately lost liberty. But he was instantly deprived of it, together with his life, by the cruel claws and teeth of the lurking cat.

1270.

A FABLE.

The ant found a grain of millet. The seed feeling itself taken prisoner cried out to her: "If you will do me the kindness to allow me accomplish my function of reproduction, I will give you a hundred such as I am." And so it was.

A Spider found a bunch of grapes which for its sweetness was much resorted to by bees and divers kinds of flies. It seemed to her that she had found a most convenient spot to spread her snare, and having settled herself on it with her delicate web, and entered into her new habitation, there, every day placing herself in the openings made by the spaces between the grapes, she fell like a thief on the wretched creatures which were not aware of her. But, after a few days had passed, the vintager came, and cut away the bunch of grapes and put it with others, with which it was trodden; and thus the grapes were a snare and pitfall both for the treacherous spider and the betrayed flies.

An ass having gone to sleep on the ice over a deep lake, his heat dissolved the ice and the ass awoke under water to his great grief, and was forthwith drowned.

A falcon, unable to endure with patience the disappearance of a duck, which, flying before him had plunged under water, wished to follow it under water, and having soaked his feathers had to remain in the water while the duck rising to the air mocked at the falcon as he drowned.

The spider wishing to take flies in her treacherous net, was cruelly killed in it by the hornet.

An eagle wanting to mock at the owl was caught by the wings in bird-lime and was taken and killed by a man.

Fables on lifeless objects (1271 — 1274).

1271.

The water finding that its element was the lordly ocean, was seized with a desire to rise above the air, and being encouraged by the element of fire and rising as a very subtle vapour, it seemed as though it were really as thin as air.

But having risen very high, it reached the air that was still more rare and cold, where the fire forsook it, and the minute particles, being brought together, united and became heavy; whence its haughtiness deserting it, it betook itself to flight and it fell from the sky, and was drunk up by the dry earth, where, being imprisoned for a long time, it did penance for its sin.

1272.

A FABLE.

The razor having one day come forth from the handle which serves as its sheath and having placed himself in the sun, saw the sun reflected in his body, which filled him with great pride. And turning it over in his thoughts he began to say to himself: "And shall I return again to that shop from which I have just come? Certainly not; such splendid beauty shall not, please God, be turned to such base uses. What folly it would be that could lead me to shave the lathered beards of rustic peasants and perform such menial service! Is this body destined for such work? Certainly not. I will hide myself in some retired spot and there pass my life in tranquil repose." And having thus remained hidden for some months, one day he came out into the air, and issuing from his sheath, saw himself turned to the similitude of a rusty saw while his surface no longer reflected the resplendent sun. With useless repentance he vainly deplored the irreparable mischief saying to himself: "Oh! how far better was it to employ at the barbers my lost edge of such exquisite keenness! Where is that lustrous surface? It has been consumed by this vexatious and unsightly rust."

The same thing happens to those minds which instead of exercise give themselves up to sloth. They are like the razor here spoken of, and lose the keenness of their edge, while the rust of ignorance spoils their form.

A FABLE.

A stone of some size recently uncovered by the water lay on a certain spot somewhat raised, and just where a delightful grove ended by a stony road; here it was surrounded by plants decorated by various flowers of divers colours. And as it saw the great quantity of stones collected together in the roadway below, it began to wish it could let itself fall down there, saying to itself: "What have I to do here with these plants? I want to live in the company of those, my sisters."

And letting itself fall, its rapid course ended among these longed for companions. When it had been there sometime it began to find itself constantly toiling under the wheels of the carts the iron-shoed feet of horses and of travellers. This one rolled it over, that one trod upon it; sometimes it lifted itself a little and then it was covered with mud or the dung of some animal, and it was in vain that it looked at the spot whence it had come as a place of solitude and tranquil place.

Thus it happens to those who choose to leave a life of solitary contemplation, and come to live in cities among people full of infinite evil.

1273.

Some flames had already lasted in the furnace of a glass-blower, when they saw a candle approaching in a beautiful and glittering candlestick. With ardent longing they strove to reach it; and one of them, quitting its natural course, writhed up to an unburnt brand on which it fed and passed at the opposite end out by a narrow chink to the candle which was near. It flung itself upon it, and with fierce jealousy and greediness it devoured it, having reduced it almost to death, and, wishing to procure the prolongation of its life, it tried to return to the furnace whence it had come. But in vain, for it was compelled to die, the wood perishing together with the candle, being at last converted, with lamentation and repentance, into foul smoke, while leaving all its sisters in brilliant and enduring life and beauty.

1274.

A small patch of snow finding itself clinging to the top of a rock which was lying on the topmost height of a very high mountain and being left to its own imaginings, it began to reflect in this way, saying to itself: “Now, shall not I be thought vain and proud for having placed myself — such a small patch of snow — in so lofty a spot, and for allowing that so large a quantity of snow as I have seen here around me, should take a place lower than mine? Certainly my small dimensions by no means merit this elevation. How easily may I, in proof of my insignificance, experience the same fate as that which the sun brought about yesterday to my companions, who were all, in a few hours, destroyed by the sun. And this happened from their having placed themselves higher than became them. I will flee from the wrath of the sun, and humble myself and find a place befitting my small importance.” Thus, flinging itself down, it began to descend,

hurrying from its high home on to the other snow; but the more it sought a low place the more its bulk increased, so that when at last its course was ended on a hill, it found itself no less in size than the hill which supported it; and it was the last of the snow which was destroyed that summer by the sun. This is said for those who, humbling themselves, become exalted.

Fables on plants (1275-1279).

1275.

The cedar, being desirous of producing a fine and noble fruit at its summit, set to work to form it with all the strength of its sap. But this fruit, when grown, was the cause of the tall and upright tree-top being bent over.

The peach, being envious of the vast quantity of fruit which she saw borne on the nut-tree, her neighbour, determined to do the same, and loaded herself with her own in such a way that the weight of the fruit pulled her up by the roots and broke her down to the ground.

The nut-tree stood always by a road side displaying the wealth of its fruit to the passers by, and every one cast stones at it.

The fig-tree, having no fruit, no one looked at it; then, wishing to produce fruits that it might be praised by men, it was bent and broken down by them.

The fig-tree, standing by the side of the elm and seeing that its boughs were bare of fruit, yet that it had the audacity to keep the Sun from its own unripe figs with its branches, said to it: "Oh elm! art thou not ashamed to stand in front of me. But wait till my offspring are fully grown and you will see where you are!" But when her offspring were mature, a troop of soldiers coming by fell upon the fig-tree and her figs were all torn off her, and her boughs cut away and broken. Then, when she was thus maimed in all her limbs, the elm asked her, saying: "O fig-tree! which was best, to be without offspring, or to be brought by them into so miserable a plight!"

1276.

The plant complains of the old and dry stick which stands by its side and of the dry stakes that surround it.

One keeps it upright, the other keeps it from low company.

1277.

A FABLE.

A nut, having been carried by a crow to the top of a tall campanile and released by falling into a chink from the mortal grip of its beak, it prayed the wall by the grace bestowed on it by God in allowing it to be so high and thick, and to own such fine bells and of so noble a tone, that it would succour it, and that, as it had not been able to fall under the verdurous boughs of its venerable father and lie in the fat earth covered up by his fallen leaves it would not abandon it; because, finding itself in the beak of the cruel crow, it had there made a vow that if it escaped from her it would end its life in a little hole. At these words the wall, moved to compassion, was content to shelter it in the spot where it had fallen; and after a short time the nut began to split open and put forth roots between the rifts of the stones and push them apart, and to throw out shoots from its hollow shell; and, to be brief, these rose above the building and the twisted roots, growing thicker, began to thrust the walls apart, and tear out the ancient stones from their old places. Then the wall too late and in vain bewailed the cause of its destruction and in a short time, it wrought the ruin of a great part of it.

1278.

A FABLE.

The privet feeling its tender boughs loaded with young fruit, pricked by the sharp claws and beak of the insolent blackbird, complained to the blackbird with piteous remonstrance entreating her that since she stole its delicious fruits she should not deprive it of the leaves with which it preserved them from the burning rays of the sun, and that she should not divest it of its tender bark by scratching it with her sharp claws. To which the blackbird replied with angry upbraiding: “O, be silent, uncultured shrub! Do you not know that Nature made you produce these fruits for my nourishment; do you not see that you are in the world [only] to serve me as food; do you not know, base creature, that next winter you will be food and prey for the Fire?” To which words the tree listened patiently, and not without tears. After a short time the blackbird was taken in a net and boughs were cut to make a cage, in which to imprison her. Branches were cut, among others from the pliant privet, to serve for the small rods of the cage; and seeing herself to be the cause of the Blackbird’s loss of liberty it rejoiced and spoke as follows: “O Blackbird, I am here, and not yet burnt by fire as you said. I shall

see you in prison before you see me burnt.”

A FABLE.

The laurel and the myrtle seeing the pear tree cut down cried out with a loud voice: “O pear-tree! whither are you going? Where is the pride you had when you were covered with ripe fruits? Now you will no longer shade us with your mass of leaves.” Then the pear-tree replied: “I am going with the husbandman who has cut me down and who will take me to the workshop of a good sculptor who by his art will make me take the form of Jove the god; and I shall be dedicated in a temple and adored by men in the place of Jove, while you are bound always to remain maimed and stripped of your boughs, which will be placed round me to do me honour.

A FABLE.

The chesnut, seeing a man upon the fig-tree, bending its boughs down and pulling off the ripe fruits, which he put into his open mouth destroying and crushing them with his hard teeth, it tossed its long boughs and with a noisy rustle exclaimed: “O fig! how much less are you protected by nature than I. See how in me my sweet offspring are set in close array; first clothed in soft wrappers over which is the hard but softly lined husk; and not content with taking this care of me, and having given them so strong a shelter, on this she has placed sharp and close-set spines so that the hand of man cannot hurt me.” Then the fig-tree and her offspring began to laugh and having laughed she said: “I know man to be of such ingenuity that with rods and stones and stakes flung up among your branches he will bereave you of your fruits; and when they are fallen, he will trample them with his feet or with stones, so that your offspring will come out of their armour, crushed and maimed; while I am touched carefully by their hands, and not like you with sticks and stones.”

1279.

The hapless willow, finding that she could not enjoy the pleasure of seeing her slender branches grow or attain to the height she wished, or point to the sky, by reason of the vine and whatever other trees that grew near, but was always maimed and lopped and spoiled, brought all her spirits together and gave and devoted itself entirely to imagination, standing plunged in long meditation and

seeking, in all the world of plants, with which of them she might ally herself and which could not need the help of her withes. Having stood for some time in this prolific imagination, with a sudden flash the gourd presented itself to her thoughts and tossing all her branches with extreme delight, it seemed to her that she had found the companion suited to her purpose, because the gourd is more apt to bind others than to need binding; having come to this conclusion she awaited eagerly some friendly bird who should be the mediator of her wishes. Presently seeing near her the magpie she said to him: "O gentle bird! by the memory of the refuge which you found this morning among my branches, when the hungry cruel, and rapacious falcon wanted to devour you, and by that repose which you have always found in me when your wings craved rest, and by the pleasure you have enjoyed among my boughs, when playing with your companions or making love — I entreat you find the gourd and obtain from her some of her seeds, and tell her that those that are born of them I will treat exactly as though they were my own flesh and blood; and in this way use all the words you can think of, which are of the same persuasive purport; though, indeed, since you are a master of language, I need not teach you. And if you will do me this service I shall be happy to have your nest in the fork of my boughs, and all your family without payment of any rent." Then the magpie, having made and confirmed certain new stipulations with the willow, — and principally that she should never admit upon her any snake or polecat, cocked his tail, and put down his head, and flung himself from the bough, throwing his weight upon his wings; and these, beating the fleeting air, now here, now there, bearing about inquisitively, while his tail served as a rudder to steer him, he came to a gourd; then with a handsome bow and a few polite words, he obtained the required seeds, and carried them to the willow, who received him with a cheerful face. And when he had scraped away with his foot a small quantity of the earth near the willow, describing a circle, with his beak he planted the grains, which in a short time began to grow, and by their growth and the branches to take up all the boughs of the willow, while their broad leaves deprived it of the beauty of the sun and sky. And not content with so much evil, the gourds next began, by their rude hold, to drag the ends of the tender shoots down towards the earth, with strange twisting and distortion.

Then, being much annoyed, it shook itself in vain to throw off the gourd. After raving for some days in such plans vainly, because the firm union forbade it, seeing the wind come by it commended itself to him. The wind flew hard and opened the old and hollow stem of the willow in two down to the roots, so that it fell into two parts. In vain did it bewail itself recognising that it was born to no good end.

III.

JESTS AND TALES.

1280.

A JEST.

A priest, making the rounds of his parish on Easter Eve, and sprinkling holy water in the houses as is customary, came to a painter's room, where he sprinkled the water on some of his pictures. The painter turned round, somewhat angered, and asked him why this sprinkling had been bestowed on his pictures; then said the priest, that it was the custom and his duty to do so, and that he was doing good; and that he who did good might look for good in return, and, indeed, for better, since God had promised that every good deed that was done on earth should be rewarded a hundred-fold from above. Then the painter, waiting till he went out, went to an upper window and flung a large pail of water on the priest's back, saying: "Here is the reward a hundred-fold from above, which you said would come from the good you had done me with your holy water, by which you have damaged my pictures."

1281.

When wine is drunk by a drunkard, that wine is revenged on the drinker.

1282.

Wine, the divine juice of the grape, finding itself in a golden and richly wrought cup, on the table of Mahomet, was puffed up with pride at so much honour; when suddenly it was struck by a contrary reflection, saying to itself: "What am I about, that I should rejoice, and not perceive that I am now near to my death and shall leave my golden abode in this cup to enter into the foul and fetid caverns of the human body, and to be transmuted from a fragrant and delicious liquor into a foul and base one. Nay, and as though so much evil as this were not enough, I must for a long time lie in hideous receptacles, together with

other fetid and corrupt matter, cast out from human intestines.” And it cried to Heaven, imploring vengeance for so much insult, and that an end might henceforth be put to such contempt; and that, since that country produced the finest and best grapes in the whole world, at least they should not be turned into wine. Then Jove made that wine drunk by Mahomet to rise in spirit to his brain; and that in so deleterious a manner that it made him mad, and gave birth to so many follies that when he had recovered himself, he made a law that no Asiatic should drink wine, and henceforth the vine and its fruit were left free.

As soon as wine has entered the stomach it begins to ferment and swell; then the spirit of that man begins to abandon his body, rising as it were skywards, and the brain finds itself parting from the body. Then it begins to degrade him, and make him rave like a madman, and then he does irreparable evil, killing his friends.

1283.

An artizan often going to visit a great gentleman without any definite purpose, the gentleman asked him what he did this for. The other said that he came there to have a pleasure which his lordship could not have; since to him it was a satisfaction to see men greater than himself, as is the way with the populace; while the gentleman could only see men of less consequence than himself; and so lords and great men were deprived of that pleasure.

1284.

Franciscan begging Friars are wont, at certain times, to keep fasts, when they do not eat meat in their convents. But on journeys, as they live on charity, they have license to eat whatever is set before them. Now a couple of these friars on their travels, stopped at an inn, in company with a certain merchant, and sat down with him at the same table, where, from the poverty of the inn, nothing was served to them but a small roast chicken. The merchant, seeing this to be but little even for himself, turned to the friars and said: “If my memory serves me, you do not eat any kind of flesh in your convents at this season.” At these words the friars were compelled by their rule to admit, without cavil, that this was the truth; so the merchant had his wish, and eat the chicken and the friars did the best they could. After dinner the messmates departed, all three together, and after travelling some distance they came to a river of some width and depth. All three being on foot — the friars by reason of their poverty, and the other from

avarice — it was necessary by the custom of company that one of the friars, being barefoot, should carry the merchant on his shoulders: so having given his wooden shoes into his keeping, he took up his man. But it so happened that when the friar had got to the middle of the river, he again remembered a rule of his order, and stopping short, he looked up, like Saint Christopher, to the burden on his back and said: “Tell me, have you any money about you?”— “You know I have”, answered the other, “How do you suppose that a Merchant like me should go about otherwise?” “Alack!” cried the friar, “our rules forbid as to carry any money on our persons,” and forthwith he dropped him into the water, which the merchant perceived was a facetious way of being revenged on the indignity he had done them; so, with a smiling face, and blushing somewhat with shame, he peaceably endured the revenge.

1285.

A JEST.

A man wishing to prove, by the authority of Pythagoras, that he had formerly been in the world, while another would not let him finish his argument, the first speaker said to the second: “It is by this token that I was formerly here, I remember that you were a miller.” The other one, feeling himself stung by these words, agreed that it was true, and that by the same token he remembered that the speaker had been the ass that carried the flour.

A JEST.

It was asked of a painter why, since he made such beautiful figures, which were but dead things, his children were so ugly; to which the painter replied that he made his pictures by day, and his children by night.

1286.

A man saw a large sword which another one wore at his side. Said he “Poor fellow, for a long time I have seen you tied to that weapon; why do you not release yourself as your hands are untied, and set yourself free?” To which the

other replied: "This is none of yours, on the contrary it is an old story." The former speaker, feeling stung, replied: "I know that you are acquainted with so few things in this world, that I thought anything I could tell you would be new to you."

1287.

A man gave up his intimacy with one of his friends because he often spoke ill of his other friends. The neglected friend one day lamenting to this former friend, after much complaining, entreated him to say what might be the cause that had made him forget so much friendship. To which he answered: "I will no longer be intimate with you because I love you, and I do not choose that you, by speaking ill of me, your friend, to others, should produce in others, as in me, a bad impression of yourself, by speaking evil to them of me, your friend. Therefore, being no longer intimate together, it will seem as though we had become enemies; and in speaking evil of me, as is your wont, you will not be blamed so much as if we continued intimate."

1288.

A man was arguing and boasting that he knew many and various tricks. Another among the bystanders said: "I know how to play a trick which will make whomsoever I like pull off his breeches." The first man — the boaster — said: "You won't make me pull off mine, and I bet you a pair of hose on it." He who proposed the game, having accepted the offer, produced breeches and drew them across the face of him who bet the pair of hose and won the bet .

A man said to an acquaintance: "Your eyes are changed to a strange colour." The other replied: "It often happens, but you have not noticed it." "When does it happen?" said the former. "Every time that my eyes see your ugly face, from the shock of so unpleasing a sight they suddenly turn pale and change to a strange colour."

A man said to another: "Your eyes are changed to a strange colour." The other replied: "It is because my eyes behold your strange ugly face."

A man said that in his country were the strangest things in the world. Another answered: "You, who were born there, confirm this as true, by the strangeness of your ugly face."

[Footnote: The joke turns, it appears, on two meanings of *trarre* and is not easily translated.]

1289.

An old man was publicly casting contempt on a young one, and boldly showing that he did not fear him; on which the young man replied that his advanced age served him better as a shield than either his tongue or his strength.

1290.

A JEST.

A sick man finding himself in *articulo mortis* heard a knock at the door, and asking one of his servants who was knocking, the servant went out, and answered that it was a woman calling herself Madonna Bona. Then the sick man lifting his arms to Heaven thanked God with a loud voice, and told the servants that they were to let her come in at once, so that he might see one good woman before he died, since in all his life he had never yet seen one.

1291.

A JEST.

A man was desired to rise from bed, because the sun was already risen. To which he replied: "If I had as far to go, and as much to do as he has, I should be risen by now; but having but a little way to go, I shall not rise yet."

1292.

A man, seeing a woman ready to hold up the target for a jousting match, exclaimed, looking at the shield, and considering his spear: "Alack! this is too small a workman for so great a business."

IV.

PROPHECIES.

THE DIVISION OF THE PROPHECIES.

First, of things relating to animals; secondly, of irrational creatures; thirdly of plants; fourthly, of ceremonies; fifthly, of manners; sixthly, of cases or edicts or quarrels; seventhly, of cases that are impossible in nature [paradoxes], as, for instance, of those things which, the more is taken from them, the more they grow. And reserve the great matters till the end, and the small matters give at the beginning. And first show the evils and then the punishment of philosophical things.

(Of Ants.)

These creatures will form many communities, which will hide themselves and their young ones and victuals in dark caverns, and they will feed themselves and their families in dark places for many months without any light, artificial or natural.

[Footnote: Lines 1 — 51 are in the original written in one column, beginning with the text of line 11. At the end of the column is the programme for the arrangement of the prophecies, placed here at the head: Lines 56 — 79 form a second column, lines 80 — 97 a third one (see the reproduction of the text on the facsimile PI. CXVIII).

Another suggestion for the arrangement of the prophecies is to be found among the notes 55 — 57 on page 357.]

(Of Bees.)

And many others will be deprived of their store and their food, and will be cruelly submerged and drowned by folks devoid of reason. Oh Justice of God! Why dost thou not wake and behold thy creatures thus ill used?

(Of Sheep, Cows, Goats and the like.)

Endless multitudes of these will have their little children taken from them ripped open and flayed and most barbarously quartered.

(Of Nuts, and Olives, and Acorns, and Chesnuts, and such like.)

Many offspring shall be snatched by cruel thrashing from the very arms of their mothers, and flung on the ground, and crushed.

(Of Children bound in Bundles.)

O cities of the Sea! In you I see your citizens — both females and males — tightly bound, arms and legs, with strong withes by folks who will not understand your language. And you will only be able to assuage your sorrows

and lost liberty by means of tearful complaints and sighing and lamentation among yourselves; for those who will bind you will not understand you, nor will you understand them.

(Of Cats that eat Rats.)

In you, O cities of Africa your children will be seen quartered in their own houses by most cruel and rapacious beasts of your own country.

(Of Asses that are beaten.)

[Footnote 48: Compare No. 845.] O Nature! Wherefore art thou so partial; being to some of thy children a tender and benign mother, and to others a most cruel and pitiless stepmother? I see children of thine given up to slavery to others, without any sort of advantage, and instead of remuneration for the good they do, they are paid with the severest suffering, and spend their whole life in benefitting those who ill treat them.

(Of Men who sleep on boards of Trees.)

Men shall sleep, and eat, and dwell among trees, in the forests and open country.

(Of Dreaming.)

Men will seem to see new destructions in the sky. The flames that fall from it will seem to rise in it and to fly from it with terror. They will hear every kind of animals speak in human language. They will instantaneously run in person in various parts of the world, without motion. They will see the greatest splendour in the midst of darkness. O! marvel of the human race! What madness has led you thus! You will speak with animals of every species and they with you in human speech. You will see yourself fall from great heights without any harm and torrents will accompany you, and will mingle with their rapid course.

(Of Christians.)

Many who hold the faith of the Son only build temples in the name of the Mother.

(Of Food which has been alive.)

A great portion of bodies that have been alive will pass into the bodies of other animals; which is as much as to say, that the deserted tenements will pass piecemeal into the inhabited ones, furnishing them with good things, and carrying with them their evils. That is to say the life of man is formed from things eaten, and these carry with them that part of man which dies . . .

1294.

(Of Funeral Rites, and Processions, and Lights, and Bells, and

Followers.)

The greatest honours will be paid to men, and much pomp, without their knowledge.

[Footnote: A facsimile of this text is on PI. CXVI below on the right, but the writing is larger than the other notes on the same sheet and of a somewhat different style. The ink is also of a different hue, as may be seen on the original sheet at Milan.]

1295.

(Of the Avaricious.)

There will be many who will eagerly and with great care and solicitude follow up a thing, which, if they only knew its malignity, would always terrify them.

(Of those men, who, the older they grow, the more avaricious they become, whereas, having but little time to stay, they should become more liberal.)

We see those who are regarded as being most experienced and judicious, when they least need a thing, seek and cherish it with most avidity.

(Of the Ditch.)

Many will be busied in taking away from a thing, which will grow in proportion as it is diminished.

(Of a Weight placed on a Feather-pillow.)

And it will be seen in many bodies that by raising the head they swell visibly; and by laying the raised head down again, their size will immediately be diminished.

(Of catching Lice.)

And many will be hunters of animals, which, the fewer there are the more will be taken; and conversely, the more there are, the fewer will be taken.

(Of Drawing Water in two Buckets with a single Rope.)

And many will be busily occupied, though the more of the thing they draw up, the more will escape at the other end.

(Of the Tongues of Pigs and Calves in Sausage-skins.)

Oh! how foul a thing, that we should see the tongue of one animal in the guts of another.

(Of Sieves made of the Hair of Animals.)

We shall see the food of animals pass through their skin everyway excepting through their mouths, and penetrate from the outside downwards to the ground.

(Of Lanterns.)

[Footnote 35: Lanterns were in Italy formerly made of horn.] The cruel horns

of powerful bulls will screen the lights of night against the wild fury of the winds.

(Of Feather-beds.)

Flying creatures will give their very feathers to support men.

(Of Animals which walk on Trees — wearing wooden Shoes.)

The mire will be so great that men will walk on the trees of their country.

(Of the Soles of Shoes, which are made from the Ox.)

And in many parts of the country men will be seen walking on the skins of large beasts.

(Of Sailing in Ships.)

There will be great winds by reason of which things of the East will become things of the West; and those of the South, being involved in the course of the winds, will follow them to distant lands.

(Of Worshipping the Pictures of Saints.)

Men will speak to men who hear not; having their eyes open, they will not see; they will speak to these, and they will not be answered. They will implore favours of those who have ears and hear not; they will make light for the blind.

(Of Sawyers.)

There will be many men who will move one against another, holding in their hands a cutting tool. But these will not do each other any injury beyond tiring each other; for, when one pushes forward the other will draw back. But woe to him who comes between them! For he will end by being cut in pieces.

(Of Silk-spinning.)

Dismal cries will be heard loud, shrieking with anguish, and the hoarse and smothered tones of those who will be despoiled, and at last left naked and motionless; and this by reason of the mover, which makes every thing turn round.

(Of putting Bread into the Mouth of the Oven and taking it out again.)

In every city, land, castle and house, men shall be seen, who for want of food will take it out of the mouths of others, who will not be able to resist in any way.

(Of tilled Land.)

The Earth will be seen turned up side down and facing the opposite hemispheres, uncovering the lurking holes of the fiercest animals.

(Of Sowing Seed.)

Then many of the men who will remain alive, will throw the victuals they have preserved out of their houses, a free prey to the birds and beasts of the earth, without taking any care of them at all.

(Of the Rains, which, by making the Rivers muddy, wash away the Land.)

[Footnote 81: Compare No. 945.] Something will fall from the sky which will transport a large part of Africa which lies under that sky towards Europe, and that of Europe towards Africa, and that of the Scythian countries will meet with tremendous revolutions [Footnote 84: Compare No. 945.].

(Of Wood that burns.)

The trees and shrubs in the great forests will be converted into cinder.

(Of Kilns for Bricks and Lime.)

Finally the earth will turn red from a conflagration of many days and the stones will be turned to cinders.

(Of boiled Fish.)

The natives of the waters will die in the boiling flood.

(Of the Olives which fall from the Olive trees, shedding oil which makes light.)

And things will fall with great force from above, which will give us nourishment and light.

(Of Owls and screech owls and what will happen to certain birds.)

Many will perish of dashing their heads in pieces, and the eyes of many will jump out of their heads by reason of fearful creatures come out of the darkness.

(Of flax which works the cure of men.)

That which was at first bound, cast out and rent by many and various beaters will be respected and honoured, and its precepts will be listened to with reverence and love.

(Of Books which teach Precepts.)

Bodies without souls will, by their contents give us precepts by which to die well.

(Of Flagellants.)

Men will hide themselves under the bark of trees, and, screaming, they will make themselves martyrs, by striking their own limbs.

(Of the Handles of Knives made of the Horns of Sheep.)

We shall see the horns of certain beasts fitted to iron tools, which will take the lives of many of their kind.

(Of Night when no Colour can be discerned.)

There will come a time when no difference can be discerned between colours, on the contrary, everything will be black alike.

(Of Swords and Spears which by themselves never hurt any one.)

One who by himself is mild enough and void of all offence will become terrible and fierce by being in bad company, and will most cruelly take the life of many men, and would kill many more if they were not hindered by bodies having no soul, that have come out of caverns — that is, breastplates of iron.

(Of Snares and Traps.)

Many dead things will move furiously, and will take and bind the living, and will ensnare them for the enemies who seek their death and destruction.

(Of Metals.)

That shall be brought forth out of dark and obscure caves, which will put the whole human race in great anxiety, peril and death. To many that seek them, after many sorrows they will give delight, and to those who are not in their company, death with want and misfortune. This will lead to the commission of endless crimes; this will increase and persuade bad men to assassinations, robberies and treachery, and by reason of it each will be suspicious of his partner. This will deprive free cities of their happy condition; this will take away the lives of many; this will make men torment each other with many artifices deceptions and treasons. O monstrous creature! How much better would it be for men that every thing should return to Hell! For this the vast forests will be devastated of their trees; for this endless animals will lose their lives.

(Of Fire.)

One shall be born from small beginnings which will rapidly become vast. This will respect no created thing, rather will it, by its power, transform almost every thing from its own nature into another.

(Of Ships which sink.)

Huge bodies will be seen, devoid of life, carrying, in fierce haste, a multitude of men to the destruction of their lives.

(Of Oxen, which are eaten.)

The masters of estates will eat their own labourers.

(Of beating Beds to renew them.)

Men will be seen so deeply ungrateful that they will turn upon that which has harboured them, for nothing at all; they will so load it with blows that a great part of its inside will come out of its place, and will be turned over and over in its body.

(Of Things which are eaten and which first are killed.)

Those who nourish them will be killed by them and afflicted by merciless deaths.

(Of the Reflection of Walls of Cities in the Water of their Ditches.)

The high walls of great cities will be seen up side down in their ditches.

(Of Water, which flows turbid and mixed with Soil and Dust; and of Mist, which is mixed with the Air; and of Fire which is mixed with its own, and each with each.)

All the elements will be seen mixed together in a great whirling mass, now

borne towards the centre of the world, now towards the sky; and now furiously rushing from the South towards the frozen North, and sometimes from the East towards the West, and then again from this hemisphere to the other.

(The World may be divided into two Hemispheres at any Point.)

All men will suddenly be transferred into opposite hemispheres.

(The division of the East from the West may be made at any point.)

All living creatures will be moved from the East to the West; and in the same way from North to South, and vice versa.

(Of the Motion of Water which carries wood, which is dead.)

Bodies devoid of life will move by themselves and carry with them endless generations of the dead, taking the wealth from the bystanders.

(Of Eggs which being eaten cannot form Chickens.)

Oh! how many will they be that never come to the birth!

(Of Fishes which are eaten unborn.)

Endless generations will be lost by the death of the pregnant.

(Of the Lamentation on Good Friday.)

Throughout Europe there will be a lamentation of great nations over the death of one man who died in the East.

(Of Dreaming.)

Men will walk and not stir, they will talk to those who are not present, and hear those who do not speak.

(Of a Man's Shadow which moves with him.)

Shapes and figures of men and animals will be seen following these animals and men wherever they flee. And exactly as the one moves the other moves; but what seems so wonderful is the variety of height they assume.

(Of our Shadow cast by the Sun, and our Reflection in the Water at one and the same time.)

Many a time will one man be seen as three and all three move together, and often the most real one quits him.

(Of wooden Chests which contain great Treasures.)

Within walnuts and trees and other plants vast treasures will be found, which lie hidden there and well guarded.

(Of putting out the Light when going to Bed.)

Many persons puffing out a breath with too much haste, will thereby lose their sight, and soon after all consciousness.

(Of the Bells of Mules, which are close to their Ears.)

In many parts of Europe instruments of various sizes will be heard making divers harmonies, with great labour to those who hear them most closely.

(Of Asses.)

The severest labour will be repaid with hunger and thirst, and discomfort, and blows, and goadings, and curses, and great abuse.

(Of Soldiers on horseback.)

Many men will be seen carried by large animals, swift of pace, to the loss of their lives and immediate death.

In the air and on earth animals will be seen of divers colours furiously carrying men to the destruction of their lives.

(Of the Stars of Spurs.)

By the aid of the stars men will be seen who will be as swift as any swift animal.

(Of a Stick, which is dead.)

The motions of a dead thing will make many living ones flee with pain and lamentation and cries.

(Of Tinder.)

With a stone and with iron things will be made visible which before were not seen.

1296.

(Of going in Ships.)

We shall see the trees of the great forests of Taurus and of Sinai and of the Appenines and others, rush by means of the air, from East to West and from North to South; and carry, by means of the air, great multitudes of men. Oh! how many vows! Oh! how many deaths! Oh! how many partings of friends and relations! Oh! how many will those be who will never again see their own country nor their native land, and who will die unburied, with their bones strewn in various parts of the world!

(Of moving on All Saints' Day.)

Many will forsake their own dwellings and carry with them all their belongings and will go to live in other parts.

(Of All Souls' Day.)

How many will they be who will bewail their deceased forefathers, carrying lights to them.

(Of Friars, who spending nothing but words, receive great gifts and bestow Paradise.)

Invisible money will procure the triumph of many who will spend it.

(Of Bows made of the Horns of Oxen.)

Many will there be who will die a painful death by means of the horns of

cattle.

(Of writing Letters from one Country to another.)

Men will speak with each other from the most remote countries, and reply.

(Of Hemispheres, which are infinite; and which are divided by an infinite number of Lines, so that every Man always has one of these Lines between his Feet.)

Men standing in opposite hemispheres will converse and deride each other and embrace each other, and understand each other's language.

(Of Priests who say Mass.)

There will be many men who, when they go to their labour will put on the richest clothes, and these will be made after the fashion of aprons [petticoats].

(Of Friars who are Confessors.)

And unhappy women will, of their own free will, reveal to men all their sins and shameful and most secret deeds.

(Of Churches and the Habitations of Friars.)

Many will there be who will give up work and labour and poverty of life and goods, and will go to live among wealth in splendid buildings, declaring that this is the way to make themselves acceptable to God.

(Of Selling Paradise.)

An infinite number of men will sell publicly and unhindered things of the very highest price, without leave from the Master of it; while it never was theirs nor in their power; and human justice will not prevent it.

(Of the Dead which are carried to be buried.)

The simple folks will carry vast quantities of lights to light up the road for those who have entirely lost the power of sight.

(Of Dowries for Maidens.)

And whereas, at first, maidens could not be protected against the violence of Men, neither by the watchfulness of parents nor by strong walls, the time will come when the fathers and parents of those girls will pay a large price to a man who wants to marry them, even if they are rich, noble and most handsome. Certainly this seems as though nature wished to eradicate the human race as being useless to the world, and as spoiling all created things.

(Of the Cruelty of Man.)

Animals will be seen on the earth who will always be fighting against each other with the greatest loss and frequent deaths on each side. And there will be no end to their malignity; by their strong limbs we shall see a great portion of the trees of the vast forests laid low throughout the universe; and, when they are filled with food the satisfaction of their desires will be to deal death and grief and labour and wars and fury to every living thing; and from their immoderate

pride they will desire to rise towards heaven, but the too great weight of their limbs will keep them down. Nothing will remain on earth, or under the earth or in the waters which will not be persecuted, disturbed and spoiled, and those of one country removed into another. And their bodies will become the sepulture and means of transit of all they have killed.

O Earth! why dost thou not open and engulf them in the fissures of thy vast abyss and caverns, and no longer display in the sight of heaven such a cruel and horrible monster.

1297.

PROPHECIES.

There will be many which will increase in their destruction.

(The Ball of Snow rolling over Snow.)

There will be many who, forgetting their existence and their name, will lie as dead on the spoils of other dead creatures.

(Sleeping on the Feathers of Birds.)

The East will be seen to rush to the West and the South to the North in confusion round and about the universe, with great noise and trembling or fury.

(In the East wind which rushes to the West.)

The solar rays will kindle fire on the earth, by which a thing that is under the sky will be set on fire, and, being reflected by some obstacle, it will bend downwards.

(The Concave Mirror kindles a Fire, with which we heat the oven, and this has its foundation beneath its roof.)

A great part of the sea will fly towards heaven and for a long time will not return. (That is, in Clouds.)

There remains the motion which divides the mover from the thing moved.

Those who give light for divine service will be destroyed. (The Bees which make the Wax for Candles)

Dead things will come from underground and by their fierce movements will send numberless human beings out of the world. (Iron, which comes from underground is dead but the Weapons are made of it which kill so many Men.)

The greatest mountains, even those which are remote from the sea shore, will drive the sea from its place.

(This is by Rivers which carry the Earth they wash away from the Mountains)

and bear it to the Sea-shore; and where the Earth comes the sea must retire.)

The water dropped from the clouds still in motion on the flanks of mountains will lie still for a long period of time without any motion whatever; and this will happen in many and divers lands.

(Snow, which falls in flakes and is Water.)

The great rocks of the mountains will throw out fire; so that they will burn the timber of many vast forests, and many beasts both wild and tame.

(The Flint in the Tinder-box which makes a Fire that consumes all the loads of Wood of which the Forests are despoiled and with this the flesh of Beasts is cooked.)

Oh! how many great buildings will be ruined by reason of Fire.

(The Fire of great Guns.)

Oxen will be to a great extent the cause of the destruction of cities, and in the same way horses and buffaloes.

(By drawing Guns.)

1298.

The Lion tribe will be seen tearing open the earth with their clawed paws and in the caves thus made, burying themselves together with the other animals that are beneath them.

Animals will come forth from the earth in gloomy vesture, which will attack the human species with astonishing assaults, and which by their ferocious bites will make confusion of blood among those they devour.

Again the air will be filled with a mischievous winged race which will assail men and beasts and feed upon them with much noise — filling themselves with scarlet blood.

1299.

Blood will be seen issuing from the torn flesh of men, and trickling down the surface.

Men will have such cruel maladies that they will tear their flesh with their own nails. (The Itch.)

Plants will be seen left without leaves, and the rivers standing still in their channels.

The waters of the sea will rise above the high peaks of the mountains towards heaven and fall again on to the dwellings of men. (That is, in Clouds.)

The largest trees of the forest will be seen carried by the fury of the winds from East to West. (That is across the Sea.)

Men will cast away their own victuals. (That is, in Sowing.)

1300.

Human beings will be seen who will not understand each other's speech; that is, a German with a Turk.

Fathers will be seen giving their daughters into the power of man and giving up all their former care in guarding them. (When Girls are married.)

Men will come out their graves turned into flying creatures; and they will attack other men, taking their food from their very hand or table. (As Flies.)

Many will there be who, flaying their mother, will tear the skin from her back. (Husbandmen tilling the Earth.)

Happy will they be who lend ear to the words of the Dead. (Who read good works and obey them.)

1031.

Feathers will raise men, as they do birds, towards heaven (that is, by the letters which are written with quills.)

The works of men's hands will occasion their death. (Swords and Spears.)

Men out of fear will cling to the thing they most fear. (That is they will be miserable lest they should fall into misery.)

Things that are separate shall be united and acquire such virtue that they will restore to man his lost memory; that is papyrus [sheets] which are made of separate strips and have preserved the memory of the things and acts of men.

The bones of the Dead will be seen to govern the fortunes of him who moves them. (By Dice.)

Cattle with their horns protect the Flame from its death. (In a Lantern [Footnote 13: See note page 357].)

The Forests will bring forth young which will be the cause of their death. (The handle of the hatchet.)

1302.

Men will deal bitter blows to that which is the cause of their life.

(In thrashing Grain.)

The skins of animals will rouse men from their silence with great outcries and curses. (Balls for playing Games.)

Very often a thing that is itself broken is the occasion of much union. (That is the Comb made of split Cane which unites the threads of Silk.)

The wind passing through the skins of animals will make men dance.

(That is the Bag-pipe, which makes people dance.)

1303.

(Of Walnut trees, that are beaten.)

Those which have done best will be most beaten, and their offspring taken and flayed or peeled, and their bones broken or crushed.

(Of Sculpture.)

Alas! what do I see? The Saviour crucified anew.

(Of the Mouth of Man, which is a Sepulchre.)

Great noise will issue from the sepulchres of those who died evil and violent deaths.

(Of the Skins of Animals which have the sense of feeling what is in the things written.)

The more you converse with skins covered with sentiments, the more wisdom will you acquire.

(Of Priests who bear the Host in their body.)

Then almost all the tabernacles in which dwells the Corpus Domini, will be plainly seen walking about of themselves on the various roads of the world.

1304.

And those who feed on grass will turn night into day (Tallow.)

And many creatures of land and water will go up among the stars (that is Planets.)

The dead will be seen carrying the living (in Carts and Ships in various places.)

Food shall be taken out of the mouth of many (the oven's mouth.)

And those which will have their food in their mouth will be deprived of it by the hands of others (the oven.)

1305.

(Of Crucifixes which are sold.)

I see Christ sold and crucified afresh, and his Saints suffering
Martyrdom.

(Of Physicians, who live by sickness.)

Men will come into so wretched a plight that they will be glad that others will
derive profit from their sufferings or from the loss of their real wealth, that is
health.

(Of the Religion of Friars, who live by the Saints who have been dead a great
while.)

Those who are dead will, after a thousand years be those who will give a
livelihood to many who are living.

(Of Stones converted into Lime, with which prison walls are made.)

Many things that have been before that time destroyed by fire will deprive
many men of liberty.

1306.

(Of Children who are suckled.)

Many Franciscans, Dominicans and Benedictines will eat that which at other
times was eaten by others, who for some months to come will not be able to
speak.

(Of Cockles and Sea Snails which are thrown up by the sea and which rot
inside their shells.)

How many will there be who, after they are dead, will putrefy inside their own
houses, filling all the surrounding air with a fetid smell.

1307.

(Of Mules which have on them rich burdens of silver and gold.)

Much treasure and great riches will be laid upon four-footed beasts, which
will convey them to divers places.

1308.

(Of the Shadow cast by a man at night with a light.)

Huge figures will appear in human shape, and the nearer you get to them, the more will their immense size diminish.

[Footnote page 1307: It seems to me probable that this note, which occurs in the note book used in 1502, when Leonardo, in the service of Cesare Borgia, visited Urbino, was suggested by the famous pillage of the riches of the palace of Guidobaldo, whose treasures Cesare Borgia at once had carried to Cesena (see GREGOROVIVS, *Geschichte der Stadt Rom im Mittelalter*. XIII, 5, 4).]

1309.

(Of Snakes, carried by Storks.)

Serpents of great length will be seen at a great height in the air, fighting with birds.

(Of great guns, which come out of a pit and a mould.)

Creatures will come from underground which with their terrific noise will stun all who are near; and with their breath will kill men and destroy cities and castles.

1310.

(Of Grain and other Seeds.)

Men will fling out of their houses those victuals which were intended to sustain their life.

(Of Trees, which nourish grafted shoots.)

Fathers and mothers will be seen to take much more delight in their step-children than in their own children.

(Of the Censer.)

Some will go about in white garments with arrogant gestures threatening others with metal and fire which will do no harm at all to them.

1311.

(Of drying Fodder.)

Innumerable lives will be destroyed and innumerable vacant spaces will be made on the earth.

(Of the Life of Men, who every year change their bodily substance.)

Men, when dead, will pass through their own bowels.

1312.

(Shoemakers.)

Men will take pleasure in seeing their own work destroyed and injured.

1313.

(Of Kids.)

The time of Herod will come again, for the little innocent children will be taken from their nurses, and will die of terrible wounds inflicted by cruel men.

V.

DRAUGHTS AND SCHEMES FOR THE HUMOROUS WRITINGS.

Schemes for fables, *etc.* (1314-1323).

1314.

A FABLE.

The crab standing under the rock to catch the fish which crept under it, it came to pass that the rock fell with a ruinous downfall of stones, and by their fall the crab was crushed.

THE SAME.

The spider, being among the grapes, caught the flies which were feeding on those grapes. Then came the vintage, and the spider was cut down with the grapes.

The vine that has grown old on an old tree falls with the ruin of that tree, and through that bad companionship must perish with it.

The torrent carried so much earth and stones into its bed, that it was then constrained to change its course.

The net that was wont to take the fish was seized and carried away by the rush of fish.

The ball of snow when, as it rolls, it descends from the snowy mountains, increases in size as it falls.

The willow, which by its long shoots hopes as it grows, to outstrip every other plant, from having associated itself with the vine which is pruned every year was always crippled.

1315.

Fable of the tongue bitten by the teeth.

The cedar puffed up with pride of its beauty, separated itself from the trees around it and in so doing it turned away towards the wind, which not being broken in its fury, flung it uprooted on the earth.

The traveller's joy, not content in its hedge, began to fling its branches out over the high road, and cling to the opposite hedge, and for this it was broken away by the passers by.

1316.

The goldfinch gives victuals to its caged young. Death rather than loss of liberty. [Footnote: Above this text is another note, also referring to liberty; see No. 694.]

1317.

(Of Bags.)

Goats will convey the wine to the city.

1318.

All those things which in winter are hidden under the snow, will be uncovered and laid bare in summer. (for Falsehood, which cannot remain hidden).

1319.

A FABLE.

The lily set itself down by the shores of the Ticino, and the current carried away bank and the lily with it.

1320.

A JEST.

Why Hungarian ducats have a double cross on them.

1321.

A SIMILE.

A vase of unbaked clay, when broken, may be remoulded, but not a baked one.

1322.

Seeing the paper all stained with the deep blackness of ink, it he deeply regrets it; and this proves to the paper that the words, composed upon it were the cause of its being preserved.

1323.

The pen must necessarily have the penknife for a companion, and it is a useful companionship, for one is not good for much without the other.

Schemes for prophecies (1324-1329).

1324.

The knife, which is an artificial weapon, deprives man of his nails, his natural

weapons.

The mirror conducts itself haughtily holding mirrored in itself the Queen. When she departs the mirror remains there ...

1325.

Flax is dedicated to death, and to the corruption of mortals. To death, by being used for snares and nets for birds, animals and fish; to corruption, by the flaxen sheets in which the dead are wrapped when they are buried, and who become corrupt in these winding sheets. — And again, this flax does not separate its fibre till it has begun to steep and putrefy, and this is the flower with which garlands and decorations for funerals should be made.

1326.

(Of Peasants who work in shirts)

Shadows will come from the East which will blacken with great colour darkness the sky that covers Italy.

(Of the Barbers.)

All men will take refuge in Africa.

1327.

The cloth which is held in the hand in the current of a running stream, in the waters of which the cloth leaves all its foulness and dirt, is meant to signify this &c.

By the thorn with inoculated good fruit is signified those natures which of themselves were not disposed towards virtue, but by the aid of their preceptors they have the repudation of it.

1328.

A COMMON THING.

A wretched person will be flattered, and these flatterers are always the deceivers,

robbers and murderers of the wretched person.

The image of the sun where it falls appears as a thing which covers the person who attempts to cover it.

(Money and Gold.)

Out of cavernous pits a thing shall come forth which will make all the nations of the world toil and sweat with the greatest torments, anxiety and labour, that they may gain its aid.

(Of the Dread of Poverty.)

The malicious and terrible [monster] will cause so much terror of itself in men that they will rush together, with a rapid motion, like madmen, thinking they are escaping her boundless force.

(Of Advice.)

The man who may be most necessary to him who needs him, will be repaid with ingratitude, that is greatly contemned.

1329.

(Of Bees.)

They live together in communities, they are destroyed that we may take the honey from them. Many and very great nations will be destroyed in their own dwellings.

1330.

WHY DOGS TAKE PLEASURE IN SMELLING AT EACH OTHER.

This animal has a horror of the poor, because they eat poor food, and it loves the rich, because they have good living and especially meat. And the excrement of animals always retains some virtue of its origin as is shown by the faeces ...

Now dogs have so keen a smell, that they can discern by their nose the virtue remaining in these faeces, and if they find them in the streets, smell them and if they smell in them the virtue of meat or of other things, they take them, and if not, they leave them: And to return to the question, I say that if by means of this smell they know that dog to be well fed, they respect him, because they judge that he has a powerful and rich master; and if they discover no such smell with the virtue of meat, they judge that dog to be of small account and to have a poor and humble master, and therefore they bite that dog as they would his master.

1331.

The circular plans of carrying earth are very useful, inasmuch as men never stop in their work; and it is done in many ways. By one of these ways men carry the earth on their shoulders, by another in chests and others on wheelbarrows. The man who carries it on his shoulders first fills the tub on the ground, and he loses time in hoisting it on to his shoulders. He with the chests loses no time. [Footnote: The subject of this text has apparently no connection with the other texts of this section.]

Irony (1332).

1332.

If Petrarch was so fond of bay, it was because it is of a good taste in sausages and with tunny; I cannot put any value on their foolery. [Footnote: Conte Porro has published these lines in the *Archivio Stor. Lombarda* VIII, IV; he reads the concluding line thus: *I no posso di loro gia (sic) co' far tesauo*. — This is known to be by a contemporary poet, as Senatore Morelli informs me.]

Tricks (1333-1335).

1333.

We are two brothers, each of us has a brother. Here the way of saying it makes it appear that the two brothers have become four.

1334.

TRICKS OF DIVIDING.

Take in each hand an equal number; put 4 from the right hand into the left; cast away the remainder; cast away an equal number from the left hand; add 5, and now you will find 13 in this [left] hand; that is-I made you put 4 from the right hand into the left, and cast away the remainder; now your right hand has 4 more; then I make you throw away as many from the right as you threw away from the left; so, throwing from each hand a quantity of which the remainder may be

equal, you now have 4 and 4, which make 8, and that the trick may not be detected I made you put 5 more, which made 13.

TRICKS OF DIVIDING.

Take any number less than 12 that you please; then take of mine enough to make up the number 12, and that which remains to me is the number which you at first had; because when I said, take any number less than 12 as you please, I took 12 into my hand, and of that 12 you took such a number as made up your number of 12; and what you added to your number, you took from mine; that is, if you had 8 to go as far as to 12, you took of my 12, 4; hence this 4 transferred from me to you reduced my 12 to a remainder of 8, and your 8 became 12; so that my 8 is equal to your 8, before it was made 12.

[Footnote 1334: G. Govi says in the 'Saggio' p. 22: *Si diletta Leonarda, di giuochi di prestigi e molti (?) ne descrisse, che si leggono poi riportati dal Paciolo nel suo libro: de Viribus Quantitatis, e che, se non tutti, sono certo in gran parte invenzioni del Vinci.*]

1335.

If you want to teach someone a subject you do not know yourself, let him measure the length of an object unknown to you, and he will learn the measure you did not know before; — Master Giovanni da Lodi.

XXI. LETTERS. PERSONAL RECORDS. DATED NOTES.

When we consider how superficial and imperfect are the accounts of Leonardo's life written some time after his death by Vasari and others, any notes or letters which can throw more light on his personal circumstances cannot fail to be in the highest degree interesting. The texts here given as Nos. 1351 — 1353, set his residence in Rome in quite a new aspect; nay, the picture which irresistibly dwells in our minds after reading these details of his life in the Vatican, forms a striking contrast to the contemporary life of Raphael at Rome.

I have placed foremost of these documents the very remarkable letters to the Defterdar of Syria. In these Leonardo speaks of himself as having staid among the mountains of Armenia, and as the biographies of the master tell nothing of any such distant journeys, it would seem most obvious to treat this passage as fiction, and so spare ourselves the onus of proof and discussion. But on close examination no one can doubt that these documents, with the accompanying sketches, are the work of Leonardo's own hand. Not merely is the character of the handwriting his, but the spelling and the language are his also. In one respect only does the writing betray any marked deviation from the rest of the notes, especially those treating on scientific questions; namely, in these observations he seems to have taken particular pains to give the most distinct and best form of expression to all he had to say; we find erasures and emendations in almost every line. He proceeded, as we shall see, in the same way in the sketches for letters to Giuliano de' Medici, and what can be more natural, I may ask, than to find the draft of a letter thus altered and improved when it is to contain an account of a definite subject, and when personal interests are in the scale? The finished copies as sent off are not known to exist; if we had these instead of the rough drafts, we might unhesitatingly have declared that some unknown Italian engineer must have been, at that time, engaged in Armenia in the service of the Egyptian Sultan, and that Leonardo had copied his documents. Under this hypothesis however we should have to state that this unknown writer must have been so far one in mind with Leonardo as to use the same style of language and even the same lines of thought. This explanation might — as I say — have been possible, if only we had the finished letters. But why should these rough drafts of

letters be regarded as anything else than what they actually and obviously are? If Leonardo had been a man of our own time, we might perhaps have attempted to account for the facts by saying that Leonardo, without having been in the East himself, might have undertaken to write a Romance of which the scene was laid in Armenia, and at the desire of his publisher had made sketches of landscape to illustrate the text.

I feel bound to mention this singular hypothesis as it has actually been put forward (see No. 1336 note 5); and it would certainly seem as though there were no other possible way of evading the conclusion to which these letters point, and their bearing on the life of the master, — absurd as the alternative is. But, if, on a question of such importance, we are justified in suggesting theories that have no foundation in probability, I could suggest another which, as compared with that of a Fiction by Leonardo, would be neither more nor less plausible; it is, moreover the only other hypothesis, perhaps, which can be devised to account for these passages, if it were possible to prove that the interpretation that the documents themselves suggest, must be rejected a priori; viz may not Leonardo have written them with the intention of mystifying those who, after his death, should try to decipher these manuscripts with a view to publishing them? But if, in fact, no objection that will stand the test of criticism can be brought against the simple and direct interpretation of the words as they stand, we are bound to regard Leonardo's travels in the East as an established fact. There is, I believe nothing in what we know of his biography to negative such a fact, especially as the details of his life for some few years are wholly unknown; nor need we be at a loss for evidence which may serve to explain — at any rate to some extent — the strangeness of his undertaking such a journey. We have no information as to Leonardo's history between 1482 and 1486; it cannot be proved that he was either in Milan or in Florence. On the other hand the tenor of this letter does not require us to assume a longer absence than a year or two. For, even if his appointment (*offitio*) as Engineer in Syria had been a permanent one, it might have become untenable — by the death perhaps of the *Defterdar*, his patron, or by his removal from office — , and Leonardo on his return home may have kept silence on the subject of an episode which probably had ended in failure and disappointment.

From the text of No. 1379 we can hardly doubt that Leonardo intended to make an excursion secretly from Rome to Naples, although so far as has hitherto been known, his biographers never allude to it. In another place (No. 1077) he says that he had worked as an Engineer in Friuli. Are we to doubt this statement too, merely because no biographer has hitherto given us any information on the matter? In the geographical notes Leonardo frequently speaks of the East, and

though such passages afford no direct proof of his having been there, they show beyond a doubt that, next to the Nile, the Euphrates, the Tigris and the Taurus mountains had a special interest in his eyes. As a still further proof of the futility of the argument that there is nothing in his drawings to show that he had travelled in the East, we find on Pl. CXX a study of oriental heads of Armenian type, — though of course this may have been made in Italy.

If the style of these letters were less sober, and the expressions less strictly to the point throughout, it might be possible to regard them as a romantic fiction instead of a narrative of fact. Nay, we have only to compare them with such obviously fanciful passages as No. 1354, Nos. 670-673, and the Fables and Prophecies. It is unnecessary to discuss the subject any further here; such explanations as the letter needs are given in the foot notes.

The drafts of letters to Lodovico il Moro are very remarkable. Leonardo and this prince were certainly far less closely connected, than has hitherto been supposed. It is impossible that Leonardo can have remained so long in the service of this prince, because the salary was good, as is commonly stated. On the contrary, it would seem, that what kept him there, in spite of his sore need of the money owed him by the prince, was the hope of some day being able to carry out the project of casting the 'gran cavallo'.

Drafts of Letters and Reports referring to Armenia (1336. 1337).

1336.

TO THE DEVATDAR OF SYRIA, LIEUTENANT OF THE SACRED
SULTAN OF
BABYLON.

The recent disaster in our Northern parts which I am certain will terrify not you alone but the whole world, which

[Footnote: Lines 1-52 are reproduced in facsimile on Pl. CXVI.

1. *Diodario*. This word is not to be found in any Italian dictionary, and for a long time I vainly sought an explanation of it. The youthful reminiscences of my wife afforded the desired clue. The chief town of each Turkish Villayet, or province — such as Broussa, for instance, in Asia Minor, is the residence of a Defterdar, who presides over the financial affairs of the province. *Defterdar hane* was, in former times, the name given to the Ministry of Finance at Constantinople; the Minister of Finance to the Porte is now known as the *Mallie-Nazri* and the *Defterdars* are his subordinates. A *Defterdar*, at the present day is merely the head of the finance department in each Provincial district. With

regard to my suggestion that Leonardo's *Diodario* might be identical with the Defterdar of former times, the late M. C. DEFREMERIE, Arabic Professor, and Membre de l'Institut de France wrote to me as follows: *Votre conjecture est parfaitement fondee; diodario est Vequivalent de devadar ou plus exactement devatdar, titre d'une importante dignite en Egypt'e, sous les Mamlouks.*

The word however is not of Turkish, but of Perso-Arabie derivation. [Defter written in arab?] literally *Defter* (Arabic) meaning *folio*; for *dar* (Persian) Bookkeeper or holder is the English equivalent; and the idea is that of a deputy in command. During the Mamelook supremacy over Syria, which corresponded in date with Leonardo's time, the office of Defterdar was the third in importance in the State.

Soltano di Babilonia. The name of Babylon was commonly applied to Cairo in the middle ages. For instance BREIDENBACH, *Itinerarium Hierosolyma* p. 218 says: "At last we reached Babylon. But this is not that Babylon which stood on the further shore of the river Chober, but that which is called the Egyptian Babylon. It is close by Cairo and the twain are but one and not two towns; one half is called Cairo and the other Babylon, whence they are called together Cairo-Babylon; originally the town is said to have been named Memphis and then Babylon, but now it is called Cairo." Compare No. 1085, 6.

Egypt was governed from 1382 till 1517 by the Borgite or Tcherkessian dynasty of the Mamelook Sultans. One of the most famous of these, Sultan Kait Bey, ruled from 1468-1496 during whose reign the Gama (or Mosque) of Kait Bey and tomb of Kait Bey near the Okella Kait Bey were erected in Cairo, which preserve his name to this day. Under the rule of this great and wise prince many foreigners, particularly Italians, found occupation in Egypt, as may be seen in the 'Viaggio di Josaphat Barbaro', among other travellers. "Next to Leonardo (so I learn from Prof. Jac. Burckhardt of Bale) Kait Bey's most helpful engineer was a German who in about 1487, superintended the construction of the Mole at Alexandria. Felix Fabri knew him and mentions him in his *Historia Suevorum*, written in 1488."

3. *Il nuovo accidente accaduto*, or as Leonardo first wrote and then erased, *e accaduto un nuovo accidente*. From the sequel this must refer to an earthquake, and indeed these were frequent at that period, particularly in Asia Minor, where they caused immense mischief. See No. 1101 note.]

shall be related to you in due order, showing first the effect and then the cause. [Footnote 4: The text here breaks off. The following lines are a fresh beginning of a letter, evidently addressed to the same person, but, as it would seem, written at a later date than the previous text. The numerous corrections and amendments amply prove that it is not a copy from any account of a journey by some

unknown person; but, on the contrary, that Leonardo was particularly anxious to choose such words and phrases as might best express his own ideas.]

Finding myself in this part of Armenia [Footnote 5: *Parti d'Erminia*. See No. 945, note. The extent of Armenia in Leonardo's time is only approximately known. In the XVth century the Persians governed the Eastern, and the Arabs the Southern portions. Arabic authors — as, for instance Abulfeda — include Cilicia and a part of Cappadocia in Armenia, and Greater Armenia was the tract of that country known later as Turcomania, while Armenia Minor was the territory between Cappadocia and the Euphrates. It was not till 1522, or even 1574 that the whole country came under the dominion of the Ottoman Turks, in the reign of Selim I.

The Mamelook Sultans of Egypt seem to have taken a particular interest in this, the most Northern province of their empire, which was even then in danger of being conquered by the Turks. In the autumn of 1477 Sultan Kait Bey made a journey of inspection, visiting Antioch and the valleys of the Tigris and Euphrates with a numerous and brilliant escort. This tour is briefly alluded to by *Moodshireddin* p. 561; and by WEIL, *Geschichte der Abbasiden* V, p. 358. An anonymous member of the suite wrote a diary of the expedition in Arabic, which has been published by R. V. LONZONE ('*Viaggio in Palestina e Soria di Kaid Ba XVIII sultano della II dinastia mamelucca, fatto nel 1477. Testo arabo. Torino 1878*', without notes or commentary). Compare the critique on this edition, by J. GILDEMEISTER in *Zeitschrift des Deutschen Palaestina Vereins* (Vol. III p. 246 — 249). Lanzzone's edition seems to be no more than an abridged copy of the original. I owe to Professor Sche'fer, Membre de l'Institut, the information that he is in possession of a manuscript in which the text is fuller, and more correctly given. The Mamelook dynasty was, as is well known, of Circassian origin, and a large proportion of the Egyptian Army was recruited in Circassia even so late as in the XVth century. That was a period of political storms in Syria and Asia Minor and it is easy to suppose that the Sultan's minister, to whom Leonardo addresses his report as his superior, had a special interest in the welfare of those frontier provinces. Only to mention a few historical events of Sultan Kait Bey's reign, we find that in 1488 he assisted the Circassians to resist the encroachments of Alaeddoulet, an Asiatic prince who had allied himself with the Osmanli to threaten the province; the consequence was a war in Cilicia by sea and land, which broke out in the following year between the contending powers. Only a few years earlier the same province had been the scene of the so-called Caramenian war in which the united Venetian, Neapolitan and Slavonic fleets had been engaged. (See CORIALANO CIPPICO, *Della guerra dei Veneziani nell' Asia dal 1469 — 1474*. Venezia

1796, p. 54) and we learn incidentally that a certain Leonardo Boldo, Governor of Scutari under Sultan Mahmoud, — as his name would indicate, one of the numerous renegades of Italian birth — played an important part in the negotiations for peace.

Tu mi mandasti. The address *tu* to a personage so high in office is singular and suggests personal intimacy; Leonardo seems to have been a favourite with the Diodario. Compare lines 54 and 55.

I have endeavoured to show, and I believe that I am also in a position to prove with regard to these texts, that they are draughts of letters actually written by Leonardo; at the same time I must not omit to mention that shortly after I had discovered

these texts in the Codex Atlanticus and published a paper on the subject in the *Zeitschrift für bildende Kunst* (Vol. XVI), Prof. Govi put forward this hypothesis to account for their origin:

“Quanto alle notizie sul monte Tauro, sull’Armenia e sull’ Asia minore che si contengono negli altri frammenti, esse vennero prese da qualche geografo o viaggiatore contemporaneo. Dall’indice imperfetto che accompagna quei frammenti, si potrebbe dedurre che Leonardo volesse farne un libro, che poi non venne compiuto. A ogni modo, non è possibile di trovare in questi brani nessun indizio di un viaggio di Leonardo in oriente, né della sua conversione alla religione di Maometto, come qualcuno pretenderebbe. Leonardo amava con passione gli studi geografici, e nei suoi scritti s’incontran spesso itinerari, indicazioni, o descrizioni di luoghi, schizzi di carte e abbozzi topografici di varie regioni, non è quindi strano che egli, abile narratore com’era, si fosse proposto di scrivere una specie di Romanzo in forma epistolare svolgendone l’intreccio nell’Asia Minore, intorno alla quale i libri d’allora, e forse qualche viaggiatore amico suo, gli avevano somministrato alcuni elementi più o meno fantastici. (See Transunti della Reale Accademia dei Lincei Voi. V Ser. 3).

It is hardly necessary to point out that Prof. Govi omits to name the sources from which Leonardo could be supposed to have drawn his information, and I may leave it to the reader to pronounce judgment on the anomaly which is involved in the hypothesis that we have here a fragment of a Romance, cast in the form of a correspondence. At the same time, I cannot but admit that the solution of the difficulties proposed by Prof. Govi is, under the circumstances, certainly the easiest way of dealing with the question. But we should then be equally justified in supposing some more of Leonardo’s letters to be fragments of such romances; particularly those of which the addresses can no longer be named. Still, as regards these drafts of letters to the Diodario, if we accept the Romance theory, as proposed by Prof. Govi, we are also compelled to assume

that Leonardo purposed from the first to illustrate his tale; for it needs only a glance at the sketches on PI. CXVI to CXIX to perceive that they are connected with the texts; and of course the rest of Leonardo's numerous notes on matters pertaining to the East, the greater part of which are here published for the first time, may also be somehow connected with this strange romance.

7. *Citta de Calindra (Chalindra)*. The position of this city is so exactly determined, between the valley of the Euphrates and the Taurus range that it ought to be possible to identify it. But it can hardly be the same as the sea port of Cilicia with a somewhat similar name Celenderis, Kelandria, Celendria, Kilindria, now the Turkish Gulnar. In two Catalonian Portulans in the Bibliotheque Natio-nale in Paris-one dating from the XV'h century, by Wilhelm von Soler, the other by Olivez de Majorca, in 1584-I find this place called Calandra. But Leonardo's Calindra must certainly have lain more to the North West, probably somewhere in Kurdistan. The fact that the geographical position is so carefully determined by Leonardo seems to prove that it was a place of no great importance and little known. It is singular that the words first written in 1. 8 were *divisa dal lago* (Lake Van?), altered afterwards to *dall'Eitfrates*.

Nostri confini, and in 1. 6 *proposito nostro*. These refer to the frontier and to the affairs of the Mamelook Sultan, Lines 65 and 66 throw some light on the purpose of Leonardo's mission.

8. *I corni del gra mote Tauro*. Compare the sketches PI. CXVI-CXVIII. So long as it is impossible to identify the situation of Calindra it is most difficult to decide with any certainty which peak of the Taurus is here meant; and I greatly regret that I had no foreknowledge of this puzzling topographical question when, in 1876, I was pursuing archaeological enquiries in the Provinces of Aleppo and Cilicia, and had to travel for some time in view of the imposing snow-peaks of Bulghar Dag and Ala Tepessi.

9-10. The opinion here expressed as to the height of the mountain would be unmeaning, unless it had been written before Leonardo moved to Milan, where Monte Rosa is so conspicuous an object in the landscape. 4 *ore inanzi* seems to mean, four hours before the sun's rays penetrate to the bottom of the valleys.]

to carry into effect with due love and care the task for which you sent me [Footnote:]; and to make a beginning in a place which seemed to me to be most to our purpose, I entered into the city of Calindrafy, near to our frontiers. This city is situated at the base of that part of the Taurus mountains which is divided from the Euphrates and looks towards the peaks of the great Mount Taurus to the West. These peaks are of such a height that they seem to touch the sky, and in all the world there is no part of the earth, higher than its summit, and the rays

of the sun always fall upon it on its East side, four hours before day-time, and being of the whitest stone [Footnote 11: *Pietra bianchissima*. The Taurus Mountains consist in great part of limestone.] it shines resplendently and fulfils the function to these Armenians which a bright moon-light would in the midst of the darkness; and by its great height it outreaches the utmost level of the clouds by a space of four miles in a straight line. This peak is seen in many places towards the West, illuminated by the sun after its setting the third part of the night. This it is, which with you [Footnote 14: *Appresso di voi*. Leonardo had at first written *noi* as though his meaning had been: This peak appeared to us to be a comet when you and I observed it in North Syria (at Aleppo? at Aintas?). The description of the curious reflection in the evening, resembling the “Alpine-glow” is certainly not an invented fiction, for in the next lines an explanation of the phenomenon is offered, or at least attempted.] we formerly in calm weather had supposed to be a comet, and appears to us in the darkness of night, to change its form, being sometimes divided in two or three parts, and sometimes long and sometimes short. And this is caused by the clouds on the horizon of the sky which interpose between part of this mountain and the sun, and by cutting off some of the solar rays the light on the mountain is intercepted by various intervals of clouds, and therefore varies in the form of its brightness.

THE DIVISIONS OF THE BOOK [Footnote 19: The next 33 lines are evidently the contents of a connected Report or Book, but not of one which he had at hand; more probably, indeed, of one he purposed writing.]

The praise and confession of the faith [Footnote 20: *Persuasione di fede*, of the Christian or the Mohammedan faith? We must suppose the latter, at the beginning of a document addressed to so high a Mohammedan official. *Predica* probably stands as an abbreviation for *predicazione* (lat. *praedicatio*) in the sense of praise or glorification; very probably it may mean some such initial doxology as we find in Mohammedan works. (Comp. 1. 40.)].

The sudden inundation, to its end.

The destruction of the city.

The death of the people and their despair.

The preacher's search, his release and benevolence [Footnote 28: The phraseology of this is too general for any conjecture as to its meaning to be worth hazarding.]

Description of the cause of this fall of the mountain [Footnote 30: *Ruina del monte*. Of course by an earthquake. In a catalogue of earthquakes, entitled *kechf aussalssaleb an auasf ezzel-zeleh*, and written by Djelal eddin].

The mischief it did.

Fall of snow.

The finding of the prophet .

His prophesy.

The inundation of the lower portion of Eastern Armenia, the draining of which was effected by the cutting through the Taurus Mountains.

How the new prophet showed [Footnote 40:*Nova profeta*, 1. 33, *profeta*. Mohammed. Leonardo here refers to the Koran:

In the name of the most merciful God. — When the earth shall be shaken by an earthquake; and the earth shall cast forth her burdens; and a man shall say, what aileth her? On that day the earth shall declare her tidings, for that thy Lord will inspire her. On that day men shall go forward in distinct classes, that they may behold their works. And whoever shall have wrought good of the weight of an ant, shall behold the same. And whoever shall have wrought evil of the weight of an ant, shall behold the same. (The Koran, translated by G. Sale, Chapter XCIX, p. 452).] that this destruction would happen as he had foretold.

Description of the Taurus Mountains and the river Euphrates.

Why the mountain shines at the top, from half to a third of the night, and looks like a comet to the inhabitants of the West after the sunset, and before day to those of the East.

Why this comet appears of variable forms, so that it is now round and now long, and now again divided into two or three parts, and now in one piece, and when it is to be seen again.

OF THE SHAPE OF THE TAURUS MOUNTAINS [Footnote 53-94: The facsimile of this passage is given on Pl. CXVII.].

I am not to be accused, Oh Devatdar, of idleness, as your chidings seem to hint; but your excessive love for me, which gave rise to the benefits you have conferred on me [Footnote 55] is that which has also compelled me to the utmost painstaking in seeking out and diligently investigating the cause of so great and stupendous an effect. And this could not be done without time; now, in order to satisfy you fully as to the cause of so great an effect, it is requisite that I should explain to you the form of the place, and then I will proceed to the effect, by which I believe you will be amply satisfied.

[Footnote 36: *Tagliata di Monte Tauro*. The Euphrates flows through the Taurus range near the influx of the Kura Shai; it rushes through a rift in the wildest cliffs from 2000 to 3000 feet high and runs on for 90 miles in 300 falls or rapids till it reaches Telek, near which at a spot called Gleikash, or the Hart's leap, it measures only 35 paces across. Compare the map on Pl. CXIX and the explanation for it on p. 391.]

[Footnote 54: The foregoing sketch of a letter, lines 5. 18, appears to have remained a fragment when Leonardo received pressing orders which caused him

to write immediately and fully on the subject mentioned in line 43.]

[Footnote 59: This passage was evidently intended as an improvement on that immediately preceding it. The purport of both is essentially the same, but the first is pitched in a key of ill-disguised annoyance which is absent from the second. I do not see how these two versions can be reconciled with the romance-theory held by Prof. Govi.] Do not be aggrieved, O Devatdar, by my delay in responding to your pressing request, for those things which you require of me are of such a nature that they cannot be well expressed without some lapse of time; particularly because, in order to explain the cause of so great an effect, it is necessary to describe with accuracy the nature of the place; and by this means I can afterwards easily satisfy your above-mentioned request. [Footnote 62: This passage was evidently intended as an improvement on that immediately preceding it. The purport of both is essentially the same, but the first is pitched in a key of ill-disguised annoyance which is absent from the second. I do not see how these two versions can be reconciled with the romance-theory held by Prof. Govi.]

I will pass over any description of the form of Asia Minor, or as to what seas or lands form the limits of its outline and extent, because I know that by your own diligence and carefulness in your studies you have not remained in ignorance of these matters ; and I will go on to describe the true form of the Taurus Mountain which is the cause of this stupendous and harmful marvel, and which will serve to advance us in our purpose . This Taurus is that mountain which, with many others is said to be the ridge of Mount Caucasus; but wishing to be very clear about it, I desired to speak to some of the inhabitants of the shores of the Caspian sea, who give evidence that this must be the true Caucasus, and that though their mountains bear the same name, yet these are higher; and to confirm this in the Scythian tongue Caucasus means a very high [Footnote 68: Caucasus; Herodot Kaoxaais; Armen. Kaukaz.] peak, and in fact we have no information of there being, in the East or in the West, any mountain so high. And the proof of this is that the inhabitants of the countries to the West see the rays of the sun illuminating a great part of its summit for as much as a quarter of the longest night. And in the same way, in those countries which lie to the East.

OF THE STRUCTURE AND SIZE OF MOUNT TAURUS.

[Footnote 73: The statements are of course founded on those of the ‘inhabitants’ spoken of in 1. 67.] The shadow of this ridge of the Taurus is of such a height that when, in the middle of June, the Sun is at its meridian, its shadow extends as

far as the borders of Sarmatia, twelve days off; and in the middle of December it extends as far as the Hyperborean mountains, which are at a month's journey to the North . And the side which faces the wind is always free from clouds and mists, because the wind which is parted in beating on the rock, closes again on the further side of that rock, and in its motion carries with it the clouds from all quarters and leaves them where it strikes. And it is always full of thunderbolts from the great quantity of clouds which accumulate there, whence the rock is all riven and full of huge debris [Footnote 77: Sudden storms are equally common on the heights of Ararat. It is hardly necessary to observe that Ararat cannot be meant here. Its summit is formed like the crater of Vesuvius. The peaks sketched on Pl. CXVI-CXVIII are probably views of the same mountain, taken from different sides. Near the solitary peak, Pl. CXVIII these three names are written *goba*, *arnigasar*, *caruda*, names most likely of different peaks. Pl. CXVI and CXVII are in the original on a single sheet folded down the middle, 30 centimetres high and 43 1/2 wide. On the reverse of one half of the sheet are notes on *peso* and *bilancia* (weight and balance), on the other are the 'prophecies' printed under Nos. 1293 and 1294. It is evident from the arrangement that these were written subsequently, on the space which had been left blank. These pages are facsimiled on Pl. CXVIII. In Pl. CXVI-CXVIII the size is smaller than in the original; the map of Armenia, Pl. CXVIII, is on Pl. CXIX slightly enlarged. On this map we find the following names, beginning from the right hand at the top: *pariades mo* (for Paryadres Mons, Arm. Parchar, now Barchal or Kolai Dag; Trebizond is on its slope).

Aquilone — North, *Antitaurus Antitaurus psis mo* (probably meant for Thospitis = Lake Van, Arm. Dgov Vanai, Tospoi, and the Mountain range to the South); *Gordis mo* (Mountains of Gordyaea), the birth place of the Tigris; *Oriente* — East; *Tigris*, and then, to the left, *Eufrates*. Then, above to the left *Argeo mo* (now Erdshigas, an extinct volcano, 12000 feet high); *Celeno mo* (no doubt Sultan Dag in Pisidia). Celeno is the Greek town of KeAouvat — see Arian I, 29, I — now the ruins of Dineir); *oriente* — East; *africo libezco* (for libeccio — South West). In the middle of the Euphrates river on this small map we see a shaded portion surrounded by mountains, perhaps to indicate the inundation mentioned in l. 35. The affluent to the Euphrates shown as coming with many windings from the high land of 'Argeo' on the West, is the Tochma Su, which joins the main river at Malatie. I have not been able to discover any map of Armenia of the XVth or XVIth century in which the course of the Euphrates is laid down with any thing like the correctness displayed in this sketch. The best I have seen is the Catalanian Portulan of Olivez de Majorca, executed in 1584, and it is far behind Leonardo's.]. This mountain, at its base, is

inhabited by a very rich population and is full of most beautiful springs and rivers, and is fertile and abounding in all good produce, particularly in those parts which face to the South. But after mounting about three miles we begin to find forests of great fir trees, and beech and other similar trees; after this, for a space of three more miles, there are meadows and vast pastures; and all the rest, as far as the beginning of the Taurus, is eternal snows which never disappear at any time, and extend to a height of about fourteen miles in all. From this beginning of the Taurus up to the height of a mile the clouds never pass away; thus we have fifteen miles, that is, a height of about five miles in a straight line; and the summit of the peaks of the Taurus are as much, or about that. There, half way up, we begin to find a scorching air and never feel a breath of wind; but nothing can live long there; there nothing is brought forth save a few birds of prey which breed in the high fissures of Taurus and descend below the clouds to seek their prey. Above the wooded hills all is bare rock, that is, from the clouds upwards; and the rock is the purest white. And it is impossible to walk to the high summit on account of the rough and perilous ascent.

1337.

[Footnote: 1337. On comparing this commencement of a letter l. 1-2 with that in l. 3 and 4 of No. 1336 it is quite evident that both refer to the same event. (Compare also No. 1337 l. 10-12 and 17 with No. 1336 l. 23, 24 and 32.) But the text No. 1336, including the fragment l. 3-4, was obviously written later than the draft here reproduced. The *Diodario* is not directly addressed — the person addressed indeed is not known — and it seems to me highly probable that it was written to some other patron and friend whose name and position are not mentioned.]

Having often made you, by my letters, acquainted with the things which have happened, I think I ought not to be silent as to the events of the last few days, which — ...

Having several times —

Having many times rejoiced with you by letters over your prosperous fortunes, I know now that, as a friend you will be sad with me over the miserable state in which I find myself; and this is, that during the last few days I have been in so much trouble, fear, peril and loss, besides the miseries of the people here, that we have been envious of the dead; and certainly I do not believe that since the elements by their separation reduced the vast chaos to order, they have ever combined their force and fury to do so much mischief to man. As far as regards

us here, what we have seen and gone through is such that I could not imagine that things could ever rise to such an amount of mischief, as we experienced in the space of ten hours. In the first place we were assailed and attacked by the violence and fury of the winds ; to this was added the falling of great mountains of snow which filled up all this valley, thus destroying a great part of our city [Footnote 11: *Della nostra citta* (Leonardo first wrote *di questa citta*). From this we may infer that he had at some time lived in the place in question wherever it might be.]. And not content with this the tempest sent a sudden flood of water to submerge all the low part of this city ; added to which there came a sudden rain, or rather a ruinous torrent and flood of water, sand, mud, and stones, entangled with roots, and stems and fragments of various trees; and every kind of thing flying through the air fell upon us; finally a great fire broke out, not brought by the wind, but carried as it would seem, by ten thousand devils, which completely burnt up all this neighbourhood and it has not yet ceased. And those few who remain unhurt are in such dejection and such terror that they hardly have courage to speak to each other, as if they were stunned. Having abandoned all our business, we stay here together in the ruins of some churches, men and women mingled together, small and great [Footnote 17: *Certe ruine di chiese*. Either of Armenian churches or of Mosques, which it was not unusual to speak of as churches.

Maschi e femmini insieme unite, implies an infringement of the usually strict rule of the separation of the sexes.], just like herds of goats. The neighbours out of pity succoured us with victuals, and they had previously been our enemies. And if

[Footnote 18: *I vicini, nostri nimici*. The town must then have stood quite close to the frontier of the country. Compare 1336. L. 7. *vicini ai nostri confini*. Dr. M. JORDAN has already published lines 4-13 (see *Das Malerbuch*, Leipzig, 1873, p. 90: — his reading differs from mine) under the title of “Description of a landscape near Lake Como”. We do in fact find, among other loose sheets in the Codex Atlanticus, certain texts referring to valleys of the Alps (see Nos. 1030, 1031 and note p. 237) and in the arrangement of the loose sheets, of which the Codex Atlanticus has been formed, these happen to be placed close to this text. The compiler stuck both on the same folio sheet; and if this is not the reason for Dr. JORDAN’S choosing such a title (Description &c.) I cannot imagine what it can have been. It is, at any rate, a merely hypothetical statement. The designation of the population of the country round a city as “the enemy” (*nemici*) is hardly appropriate to Italy in the time of Leonardo.]

it had not been for certain people who succoured us with victuals, all would have died of hunger. Now you see the state we are in. And all these evils are as

nothing compared with those which are promised to us shortly.

I know that as a friend you will grieve for my misfortunes, as I, in former letters have shown my joy at your prosperity ...

Notes about events observed abroad (1338-1339).

1338.

BOOK 43. OF THE MOVEMENT OF AIR ENCLOSED IN WATER.

I have seen motions of the air so furious that they have carried, mixed up in their course, the largest trees of the forest and whole roofs of great palaces, and I have seen the same fury bore a hole with a whirling movement digging out a gravel pit, and carrying gravel, sand and water more than half a mile through the air.

[Footnote: The first sixteen lines of this passage which treat of the subject as indicated on the title line have no place in this connexion and have been omitted.]

[Footnote 2: *Ho veduto movimenti* &c. Nothing of the kind happened in Italy during Leonardo's lifetime, and it is therefore extremely probable that this refers to the natural phenomena which are so fully described in the foregoing passage. (Compare too, No. 1021.) There can be no doubt that the descriptions of the Deluge in the Libro di Pittura (Vol. I, No. 607-611), and that of the fall of a mountain No. 610, l. 17-30 were written from the vivid impressions derived from personal experience. Compare also Pl. XXXIV-XL.]

1339.

[Footnote: It may be inferred from the character of the writing, which is in the style of the note in facsimile Vol. I, p. 297, that this passage was written between 1470 and 1480. As the figure 6 at the end of the text indicates, it was continued on another page, but I have searched in vain for it. The reverse of this leaf is coloured red for drawing in silver point, but has not been used for that purpose but for writing on, and at about the same date. The passages are given as Nos. 1217, 1218, 1219, 1162 and No. 994 (see note page 218). The text given above is obviously not a fragment of a letter, but a record of some personal experience. No. 1379 also seems to refer to Leonardo's journeys in Southern Italy.]

Like a whirling wind which rushes down a sandy and hollow valley, and

which, in its hasty course, drives to its centre every thing that opposes its furious course ...

No otherwise does the Northern blast whirl round in its tempestuous progress ...

Nor does the tempestuous sea bellow so loud, when the Northern blast dashes it, with its foaming waves between Scylla and Charybdis; nor Stromboli, nor Mount Etna, when their sulphurous flames, having been forcibly confined, rend, and burst open the mountain, fulminating stones and earth through the air together with the flames they vomit.

Nor when the inflamed caverns of Mount Etna [Footnote 13: Mongibello is a name commonly given in Sicily to Mount Etna (from Djebel, Arab.=mountain). Fr. FERRARA, *Descrizione dell' Etna con la storia delle eruzioni* (Palermo, 1818, p. 88) tells us, on the authority of the *Cronaca del Monastero Benedettino di Licordia* of an eruption of the Volcano with a great flow of lava on Sept. 21, 1447. The next records of the mountain are from the years 1533 and 1536. A. Percy neither does mention any eruptions of Etna during the years to which this note must probably refer *Memoire des tremblements de terre de la peninsule italique, Vol. XXII des Memoires couronnees et Memoires des savants etrangers. Academie Royal de Belgique*).

A literal interpretation of the passage would not, however, indicate an allusion to any great eruption; particularly in the connection with Stromboli, where the periodical outbreaks in very short intervals are very striking to any observer, especially at night time, when passing the island on the way from Naples to Messina.], rejecting the ill-restrained element vomit it forth, back to its own region, driving furiously before it every obstacle that comes in the way of its impetuous rage ...

Unable to resist my eager desire and wanting to see the great ... of the various and strange shapes made by formative nature, and having wandered some distance among gloomy rocks, I came to the entrance of a great cavern, in front of which I stood some time, astonished and unaware of such a thing. Bending my back into an arch I rested my left hand on my knee and held my right hand over my down-cast and contracted eye brows: often bending first one way and then the other, to see whether I could discover anything inside, and this being forbidden by the deep darkness within, and after having remained there some time, two contrary emotions arose in me, fear and desire — fear of the threatening dark cavern, desire to see whether there were any marvellous thing within it ...

Drafts of Letters to Lodovico il Moro (1340-1345).

1340.

[Footnote: The numerous corrections, the alterations in the figures (l. 18) and the absence of any signature prove that this is merely the rough draft of a letter to Lodovico il Moro. It is one of the very few manuscripts which are written from left to right — see the facsimile of the beginning as here reproduced. This is probably the final sketch of a document the clean of which copy was written in the usual manner. Leonardo no doubt very rarely wrote so, and this is probably the reason of the conspicuous dissimilarity in the handwriting, when he did. (Compare Pl. XXXVIII.) It is noteworthy too that here the orthography and abbreviations are also exceptional. But such superficial peculiarities are not enough to stamp the document as altogether spurious. It is neither a forgery nor the production of any artist but Leonardo himself. As to this point the contents leave us no doubt as to its authenticity, particularly l. 32 (see No. 719, where this passage is repeated). But whether the fragment, as we here see it, was written from Leonardo's dictation — a theory favoured by the orthography, the erasures and corrections — or whether it may be a copy made for or by Melzi or Mazenta is comparatively unimportant. There are in the Codex Atlanticus a few other documents not written by Leonardo himself, but the notes in his own hand found on the reverse pages of these leaves amply prove that they were certainly in Leonardo's possession. This mark of ownership is wanting to the text in question, but the compilers of the Codex Atlanticus, at any rate, accepted it as a genuine document.

With regard to the probable date of this projected letter see Vol.

II, p. 3.]

Most illustrious Lord, Having now sufficiently considered the specimens of all those who proclaim themselves skilled contrivers of instruments of war, and that the invention and operation of the said instruments are nothing different to those in common use: I shall endeavour, without prejudice to any one else, to explain myself to your Excellency showing your Lordship my secrets, and then offering them to your best pleasure and approbation to work with effect at opportune moments as well as all those things which, in part, shall be briefly noted below.

1) I have a sort of extremely light and strong bridges, adapted to be most easily carried, and with them you may pursue, and at any time flee from the enemy; and others, secure and indestructible by fire and battle, easy and convenient to lift and place. Also methods of burning and destroying those of the enemy.

2) I know how, when a place is besieged, to take the water out of the trenches,

and make endless variety of bridges, and covered ways and ladders, and other machines pertaining to such expeditions.

3) Item. If, by reason of the height of the banks, or the strength of the place and its position, it is impossible, when besieging a place, to avail oneself of the plan of bombardment, I have methods for destroying every rock or other fortress, even if it were founded on a rock, &c.

4) Again I have kinds of mortars; most convenient and easy to carry; and with these can fling small stones almost resembling a storm; and with the smoke of these causing great terror to the enemy, to his great detriment and confusion.

9) And when the fight should be at sea I have kinds of many machines most efficient for offence and defence; and vessels which will resist the attack of the largest guns and powder and fumes.

5) Item. I have means by secret and tortuous mines and ways, made without noise to reach a designated [spot], even if it were needed to pass under a trench or a river.

6) Item. I will make covered chariots, safe and unattackable which, entering among the enemy with their artillery, there is no body of men so great but they would break them. And behind these, infantry could follow quite unhurt and without any hindrance.

7) Item. In case of need I will make big guns, mortars and light ordnance of fine and useful forms, out of the common type.

8) Where the operation of bombardment should fail, I would contrive catapults, mangonels, *trabocchi* and other machines of marvellous efficacy and not in common use. And in short, according to the variety of cases, I can contrive various and endless means of offence and defence.

10) In time of peace I believe I can give perfect satisfaction and to the equal of any other in architecture and the composition of buildings public and private; and in guiding water from one place to another.

Item: I can carry out sculpture in marble, bronze or clay, and also in painting whatever may be done, and as well as any other, be he whom he may.

Again, the bronze horse may be taken in hand, which is to be to the immortal glory and eternal honour of the prince your father of happy memory, and of the illustrious house of Sforza.

And if any one of the above-named things seem to any one to be impossible or not feasible, I am most ready to make the experiment in your park, or in whatever place may please your Excellency — to whom I commend myself with the utmost humility &c.

1341.

To my illustrious Lord, Lodovico, Duke of Bari, Leonardo da Vinci of
Florence — Leonardo.

[Footnote: Evidently a note of the superscription of a letter to the Duke, and written, like the foregoing from left to right. The manuscript containing it is of the year 1493. Lodovico was not proclaimed and styled Duke of Milan till September 1494. The Dukedom of Bari belonged to the Sforza family till 1499.]

1342.

You would like to see a model which will prove useful to you and to me, also it will be of use to those who will be the cause of our usefulness.

[Footnote: 1342. 1343. These two notes occur in the same not very voluminous MS. as the former one and it is possible that they are fragments of the same letter. By the *Modello*, the equestrian statue is probably meant, particularly as the model of this statue was publicly exhibited in this very year, 1493, on the occasion of the marriage of the Emperor Maximilian with Bianca Maria Sforza.]

1343.

There are here, my Lord, many gentlemen who will undertake this expense among them, if they are allowed to enjoy the use of admission to the waters, the mills, and the passage of vessels and when it is sold to them the price will be repaid to them by the canal of Martesana.

1344.

I am greatly vexed to be in necessity, but I still more regret that this should be the cause of the hindrance of my wish which is always disposed to obey your Excellency.

Perhaps your Excellency did not give further orders to Messer Gualtieri, believing that I had money enough.

I am greatly annoyed that you should have found me in necessity, and that my having to earn my living should have hindered me ...

It vexes me greatly that having to earn my living has forced me to interrupt

the work and to attend to small matters, instead of following up the work which your Lordship entrusted to me. But I hope in a short time to have earned so much that I may carry it out quietly to the satisfaction of your Excellency, to whom I commend myself; and if your Lordship thought that I had money, your Lordship was deceived. I had to feed 6 men for 56 months, and have had 50 ducats.

1345.

And if any other comission is given me by any ... of the reward of my service. Because I am not [able] to be ... things assigned because meanwhile they have ... to them ... which they well may settle rather than I ... not my art which I wish to change and ... given some clothing if I dare a sum ...

My Lord, I knowing your Excellency's
mind to be occupied ...
to remind your Lordship of my small matters
and the arts put to silence
that my silence might be the cause of making
your Lordship scorn ...
my life in your service. I hold myself ever
in readiness to obey ...

[Footnote 11: See No. 723, where this passage is repeated.]

Of the horse I will say nothing because I know the times [are bad] to your Lordship how I had still to receive two years' salary of the ... with the two skilled workmen who are constantly in my pay and at my cost that at last I found myself advanced the said sum about 15 lire ... works of fame by which I could show to those who shall see it that I have been everywhere, but I do not know where I could bestow my work [more] ...

[Footnote 17: See No. 1344 l. 12.] I, having been working to gain my living ...

I not having been informed what it is, I find myself ...

[Footnote 19: In April, 1498, Leonardo was engaged in painting the Saletta Nigra of the Castello at Milan. (See G. MONGERI, *l'Arte in Milano*, 1872, p. 417.)]

remember the commission to paint the rooms ...
I conveyed to your Lordship only requesting
you ...

[Footnote: The paper on which this is written is torn down the middle; about

half of each line remains.]

Draft of letter to be sent to Piacenza (1346. 1347).

[Footnote: 1346. 1347. Piacenza belonged to Milan. The Lord spoken of in this letter, is no doubt Lodovico il Moro. One may infer from the concluding sentence (No. 1346, l. 33. 34 and No. 1347), that Leonardo, who no doubt compiled this letter, did not forward it to Piacenza himself, but gave it to some influential patron, under whose name and signature a copy of it was sent to the Commission.]

1346.

Magnificent Commissioners of Buildings I, understanding that your Magnificencies have made up your minds to make certain great works in bronze, will remind you of certain things: first that you should not be so hasty or so quick to give the commission, lest by this haste it should become impossible to select a good model and a good master; and some man of small merit may be chosen, who by his insufficiency may cause you to be abused by your descendants, judging that this age was but ill supplied with men of good counsel and with good masters; seeing that other cities, and chiefly the city of the Florentines, has been as it were in these very days, endowed with beautiful and grand works in bronze; among which are the doors of their Baptistery. And this town of Florence, like Piacenza, is a place of intercourse, through which many foreigners pass; who, seeing that the works are fine and of good quality, carry away a good impression, and will say that that city is well filled with worthy inhabitants, seeing the works which bear witness to their opinion; and on the other hand, I say seeing so much metal expended and so badly wrought, it were less shame to the city if the doors had been of plain wood; because, the material, costing so little, would not seem to merit any great outlay of skill...

Now the principal parts which are sought for in cities are their cathedrals, and of these the first things which strike the eye are the doors, by which one passes into these churches.

Beware, gentlemen of the Commission, lest too great speed in your determination, and so much haste to expedite the entrusting of so great a work as that which I hear you have ordered, be the cause that that which was intended for the honour of God and of men should be turned to great dishonour of your judgments, and of your city, which, being a place of mark, is the resort and gathering-place of innumerable foreigners. And this dishonour would result if by your lack of diligence you were to put your trust in some vaunter, who by his

tricks or by favour shown to him here should obtain such work from you, by which lasting and very great shame would result to him and to you. Thus I cannot help being angry when I consider what men those are who have conferred with you as wishing to undertake this great work without thinking of their sufficiency for it, not to say more. This one is a potter, that one a maker of cuirasses, this one is a bell-founder, another a bell ringer, and one is even a bombardier; and among them one in his Lordship's service, who boasted that he was the gossip of Messer Ambrosio Ferrere [Footnote 26: Messer Ambrogio Ferrere was Farmer of the Customs under the Duke. Piacenza at that time belonged to Milan.], who has some power and who has made him some promises; and if this were not enough he would mount on horseback, and go to his Lord and obtain such letters that you could never refuse [to give] him the work. But consider where masters of real talent and fit for such work are brought when they have to compete with such men as these. Open your eyes and look carefully lest your money should be spent in buying your own disgrace. I can declare to you that from that place you will procure none but average works of inferior and coarse masters. There is no capable man, — and you may believe me, — except Leonardo the Florentine, who is making the equestrian statue in bronze of the Duke Francesco and who has no need to bring himself into notice, because he has work for all his life time; and I doubt, whether being so great a work, he will ever finish it .

The miserable painstakers ... with what hope may they expect a reward of their merit?

1347.

There is one whom his Lordship invited from Florence to do this work and who is a worthy master, but with so very much business he will never finish it; and you may imagine that a difference there is to be seen between a beautiful object and an ugly one. Quote Pliny.

Letter to the Cardinal Ippolito d' Este.

1348.

[Footnote: This letter addressed to the Cardinal Ippolito d'Este is here given from Marchese G. CAMPORI'S publication: *Nuovi documenti per la Vita di Leonardo da Vinci. Atti e Memorie delle R. R. Deputazioni di Storia patria per la provincie modenesi e parmenesi*, Vol. III. It is the only text throughout this

work which I have not myself examined and copied from the original. The learned discoverer of this letter — the only letter from Leonardo hitherto known as having been sent — adds these interesting remarks: *Codesto Cardinale nato ad Ercole I. nel 1470, arcivescovo di Strigonia a sette anni, poi d'Agra, aveva conseguito nel 1497 la pingue ed ambita cattedra di Milano, la dove avra conosciuto il Vinci, sebbene il poco amore ch'ei professava alle arti lasci credere che le proteste di servitu di Leonardo piu che a gratitudine per favori ricevuti e per opere a lui allogate, accennino a speranza per un favore che si aspetta. Notabile e ancora in questo prezioso documento la ripetuta signatura del grande artista 'che si scrive Vincio e Vincius, non da Vinci come si tiene comunemente, sebbene l'una e l'altra possano valere a significare cosi il casato come il paese; restando a sapere se il nome del paese di Vinci fosse assunto a cognome della famiglia di Leonardo nel qual supposto piu propriamente avrebbe a chiamarsi Leonardo Vinci, o Vincio (latinamente Vincius) com'egli stesso amo segnarsi in questa lettera, e come scrissero parecchi contenporanei di lui, il Casio, il Cesariano, Geoffrey Tory, il Gaurico, il Bandello, Raffaelle Maffei, il Paciolo. Per ultimo non lascero d'avvertire come la lettera del Vinci e assai ben conservata, di nitida e larga scrittura in forma pienamente corrispondente a quella dei suoi manoscritti, vergata all'uso comune da sinistra a destra, anziche contrariamente come fu suo costume; ma indubbiamente autentica e fornita della menzione e del suggello che fresca ancora conserva l'impronta di una testa di profilo da un picciolo antico cammeo. (Compare No. 1368, note.)]*

Most Illustrious and most Reverend Lord.

The Lord Ippolito, Cardinal of Este
at Ferrare.

Most Illustrious and most Reverend Lord.

I arrived from Milan but a few days since and finding that my elder brother refuses to

carry into effect a will, made three years ago when my father died — as also, and no less, because I would not fail in a matter I esteem most important — I cannot forbear to crave of your most Reverend Highness a letter of recommendation and favour to Ser Raphaello Hieronymo, at present one of the illustrious members of the Signoria before whom my cause is being argued; and more particularly it has been laid by his Excellency the Gonfaloniere into the hands of the said Ser Raphaello, that his Worship may have to decide and end it before the festival of All Saints. And therefore, my Lord, I entreat you, as urgently as I know how and am able, that your Highness will write a letter to the said Ser Raphaello in that admirable and pressing manner which your Highness

can use, recommending to him Leonardo Vincio, your most humble servant as I am, and shall always be; requesting him and pressing him not only to do me justice but to do so with despatch; and I have not the least doubt, from many things that I hear, that Ser Raphaello, being most affectionately devoted to your Highness, the matter will issue *ad votum*. And this I shall attribute to your most Reverend Highness' letter, to whom I once more humbly commend myself. *Et bene valeat*.

Florence XVIIIa 7bris 1507.

E. V. R. D.

your humble servant Leonardus Vinci, pictor.

Draft of Letter to the Governor of Milan.

1349.

I am afraid lest the small return I have made for the great benefits, I have received from your Excellency, have not made you somewhat angry with me, and that this is why to so many letters which I have written to your Lordship I have never had an answer. I now send Salai to explain to your Lordship that I am almost at an end of the litigation I had with my brother; that I hope to find myself with you this Easter, and to carry with me two pictures of two Madonnas of different sizes. These were done for our most Christian King, or for whomsoever your Lordship may please. I should be very glad to know on my return thence where I may have to reside, for I would not give any more trouble to your Lordship. Also, as I have worked for the most Christian King, whether my salary is to continue or not. I wrote to the President as to that water which the king granted me, and which I was not put in possession of because at that time there was a dearth in the canal by reason of the great droughts and because [Footnote: Compare Nos. 1009 and 1010. Leonardo has noted the payment of the pension from the king in 1505.] its outlets were not regulated; but he certainly promised me that when this was done I should be put in possession. Thus I pray your Lordship that you will take so much trouble, now that these outlets are regulated, as to remind the President of my matter; that is, to give me possession of this water, because on my return I hope to make there instruments and other things which will greatly please our most Christian King. Nothing else occurs to me. I am always yours to command. [Footnote: 1349. Charles d'Amboise, Marechal de Chaumont, was Governor of Milan under Louis XII. Leonardo was in personal communication with him so early as in 1503. He was absent from Milan in the autumn of 1506 and from October 1510 — when he besieged Pope

Julius II. in Bologna — till his death, which took place at Correggio, February 11, 1511. Francesco Vinci, Leonardo's uncle, died — as Amoretti tells us — in the winter of 1510-11 (or according to Uzielli in 1506?), and Leonardo remained in Florence for business connected with his estate. The letter written with reference to this affair, No. 1348, is undoubtedly earlier than the letters Nos. 1349 and 1350. Amoretti tells us, *Memorie Storiche*, ch. II, that the following note existed on the same leaf in MS. C. A. I have not however succeeded in finding it. The passage runs thus: *Jo sono quasi al fine del mio letizio che io o con mie fratetgli ... Ancora ricordo a V. Excia la facenda che o cum Ser Juliana mio Fratello capo delli altri fratelli ricordandoli come se offerse di conciar le cose nostre fra noi fratelli del comune della eredita de mio Zio, e quelli costringa alla expeditione, quale conteneva la lettera che lui me mando.]*

Drafts of Letters to the Superintendent of Canals and to Fr. Melzi.

1350.

Magnificent President, I am sending thither Salai, my pupil, who is the bearer of this, and from him you will hear by word of mouth the cause of my...

Magnificent President, I...

Magnificent President: — Having oftentimes remembered the proposals made many times to me by your Excellency, I take the liberty of writing to remind your Lordship of the promise made to me at my last departure, that is the possession of the twelve inches of water granted to me by the most Christian King. Your Lordship knows that I did not enter into possession, because at that time when it was given to me there was a dearth of water in the canal, as well by reason of the great drought as also because the outlets were not regulated; but your Excellency promised me that as soon as this was done, I should have my rights. Afterwards hearing that the canal was complete I wrote several times to your Lordship and to Messer Girolamo da Cusano, who has in his keeping the deed of this gift; and so also I wrote to Corigero and never had a reply. I now send thither Salai, my pupil, the bearer of this, to whom your Lordship may tell by word of mouth all that happened in the matter about which I petition your Excellency. I expect to go thither this Easter since I am nearly at the end of my lawsuit, and I will take with me two pictures of our Lady which I have begun, and at the present time have brought them on to a very good end; nothing else occurs to me.

My Lord the love which your Excellency has always shown me and the benefits that I have constantly received from you I have hitherto...

I am fearful lest the small return I have made for the great benefits I have received from your Excellency may not have made you somewhat annoyed with me. And this is why, to many letters which I have written to your Excellency I have never had an answer. I now send to you Salai to explain to your Excellency that I am almost at the end of my litigation with my brothers, and that I hope to be with you this Easter and carry with me two pictures on which are two Madonnas of different sizes which I began for the most Christian King, or for whomsoever you please. I should be very glad to know where, on my return from this place, I shall have to reside, because I do not wish to give more trouble to your Lordship; and then, having worked for the most Christian King, whether my salary is to be continued or not. I write to the President as to the water that the king granted me of which I had not been put in possession by reason of the dearth in the canal, caused by the great drought and because its outlets were not regulated; but he promised me certainly that as soon as the regulation was made, I should be put in possession of it; I therefore pray you that, if you should meet the said President, you would be good enough, now that the outlets are regulated, to remind the said President to cause me to be put in possession of that water, since I understand it is in great measure in his power. Nothing else occurs to me; always yours to command.

Good day to you Messer Francesco. Why, in God's name, of all the letters I have written to you, have you never answered one. Now wait till I come, by God, and I shall make you write so much that perhaps you will become sick of it.

Dear Messer Francesco. I am sending thither Salai to learn from His Magnificence the President to what end the regulation of the water has come since, at my departure this regulation of the outlets of the canal had been ordered, because His Magnificence the President promised me that as soon as this was done I should be satisfied. It is now some time since I heard that the canal was in order, as also its outlets, and I immediately wrote to the President and to you, and then I repeated it, and never had an answer. So you will have the goodness to answer me as to that which happened, and as I am not to hurry the matter, would you take the trouble, for the love of me, to urge the President a little, and also Messer Girolamo Cusano, to whom you will commend me and offer my duty to his Magnificence.

[Footnote: 1350. 28-36. Draft of a letter to Francesco Melzi, born 1493 — a youth therefore of about 17 in 1510. Leonardo addresses his young friend as “Messer”, as being the son of a noble house. Melzi practised art under Leonardo as a dilettante and not as a pupil, like Cesare da Sesto and others (See LERMOLIEFF, *Die Galerien* &c., p. 476).]

Drafts of a letter to Giuliano de' Medici (1351-1352).

1351.

[Most illustrious Lord. I greatly rejoice most Illustrious Lord at your...]

I was so greatly rejoiced, most illustrious Lord, by the desired restoration of your health, that it almost had the effect that [my own health recovered] — [I have got through my illness] — my own illness left me — of your Excellency's almost restored health. But I am extremely vexed that I have not been able completely to satisfy the wishes of your Excellency, by reason of the wickedness of that deceiver, for whom I left nothing undone which could be done for him by me and by which I might be of use to him; and in the first place his allowances were paid to him before the time, which I believe he would willingly deny, if I had not the writing signed by myself and the interpreter. And I, seeing that he did not work for me unless he had no work to do for others, which he was very careful in solliciting, invited him to dine with me, and to work afterwards near me, because, besides the saving of expense, he

[Footnote 1351. 1353: It is clear from the contents of this notes that they refer to Leonardo's residence in Rome in 1513-1515. Nor can there be any doubt that they were addressed to Leonardo's patron at the time: Giuliano de' Medici, third son of Lorenzo the Magnificent and brother of Pope Leo X (born 1478). In 1512 he became the head of the Florentine Republic. The Pope invited him to Rome, where he settled; in 1513 he was named patrician with much splendid ceremonial. The medal struck in honour of the event bears the words MAG. IVLIAN. MEDICES. Leonardo too uses the style "Magnifico", in his letter. Compare also No. 1377.

GINO CAPPONI (*Storia della Repubblica di Firenze*, Vol. III, p. 139) thus describes the character of Giuliano de' Medici, who died in 1516: *Era il migliore della famiglia, di vita placida, grande spenditore, tenendo intorno a se uomini ingegnosi, ed ogni nuova cosa voleva provare.*

See too GREGOROVIVS, *Geschichte der Stadi Rom*, VIII (book XIV. III, 2): *Die Luftschlosser fürstlicher Grosse, wozu ihn der Papst hatte erheben wollen zerfielen. Julian war der edelste aller damaligen Medici, ein Mensch von innerlicher Richtung, unbefriedigt durch das Leben, mitten im Sonnenglanz der Herrlichkeit Leo's X. eine dunkle Gestalt die wie ein Schatten vorüberzog.* Giuliano lived in the Vatican, and it may be safely inferred from No. 1352 l. 2, and No. 1353 l. 4, that Leonardo did the same.

From the following unpublished notice in the Vatican archives, which M. Eug. Muntz, librarian of the Ecole des Beaux arts, Paris, has done me the favour to communicate to me, we get a more accurate view of Leonardo's relation to the often named GIORGIO TEDESCO:

Nota delle provisione (sic) a da pagare per me in nome del nostro ill. S.

Bernardo Bini e chompa di Roma, e prima della illma sua chonsorte ogni mese d. 800.

A Ldo da Vinci per sua provisione d. XXXIII, e piu d. VII al detto per la provisione di Giorgio tedesco, che sono in tutto d. 40.

From this we learn, that seven ducats formed the German's monthly wages, but according to No. 1353 l. 7 he pretended that eight ducats had been agreed upon.]

would acquire the Italian language. He always promised, but would never do so. And this I did also, because that Giovanni, the German who makes the mirrors, was there always in the workshop, and wanted to see and to know all that was being done there and made it known outside ... strongly criticising it; and because he dined with those of the Pope's guard, and then they went out with guns killing birds among the ruins; and this went on from after dinner till the evening; and when I sent Lorenzo to urge him to work he said that he would not have so many masters over him, and that his work was for your Excellency's Wardrobe; and thus two months passed and so it went on; and one day finding Gian Niccolo of the Wardrobe and asking whether the German had finished the work for your Magnificence, he told me this was not true, but only that he had given him two guns to clean. Afterwards, when I had urged him farther, he left the workshop and began to work in his room, and lost much time in making another pair of pincers and files and other tools with screws; and there he worked at mills for twisting silk which he hid when any one of my people went in, and with a thousand oaths and mutterings, so that none of them would go there any more.

I was so greatly rejoiced, most Illustrious Lord, by the desired restoration of your health, that my own illness almost left me. But I am greatly vexed at not having been able to completely satisfy your Excellency's wishes by reason of the wickedness of that German deceiver, for whom I left nothing undone by which I could have hope to please him; and secondly I invited him to lodge and board with me, by which means I should constantly see the work he was doing and with greater ease correct his errors while, besides this, he would learn the Italian tongue, by means of which he could with more ease talk without an interpreter; his moneys were always given him in advance of the time when due. Afterwards he wanted to have the models finished in wood, just as they were to be in iron, and wished to carry them away to his own country. But this I refused him, telling him that I would give him, in drawing, the breadth, length, height and form of what he had to do; and so we remained in ill-will.

The next thing was that he made himself another workshop and pincers and tools in his room where he slept, and there he worked for others; afterwards he

went to dine with the Swiss of the guard, where there are idle fellows, in which he beat them all; and most times they went two or three together with guns, to shoot birds among the ruins, and this went on till evening.

At last I found how this master Giovanni the mirror-maker was he who had done it all, for two reasons; the first because he had said that my coming here had deprived him of the countenance and favour of your Lordship which always... The other is that he said that his iron-workers' rooms suited him for working at his mirrors, and of this he gave proof; for besides making him my enemy, he made him sell all he had and leave his workshop to him, where he works with a number of workmen making numerous mirrors to send to the fairs.

1352.

I was so greatly rejoiced, most Illustrious Lord, by the wished for recovery of your health, that my own ills have almost left me; and I say God be praised for it. But it vexes me greatly that I have not been able completely to satisfy your Excellency's wishes by reason of the wickedness of that German deceiver, for whom I left nothing undone by which I could hope to please him; and secondly I invited him to lodge and board with me, by which means I should see constantly the work he was doing, for which purpose I would have a table fixed at the foot of one of these windows, where he could work with the file and finish the things made below; and so I should constantly see the work he might do, and it could be corrected with greater ease.

Draft of letter written at Rome.

1353.

This other hindered me in anatomy, blaming it before the Pope; and likewise at the hospital; and he has filled this whole Belvedere with workshops for mirrors; and he did the same thing in Maestro Giorgio's room. He said that he had been promised eight ducats every month, beginning with the first day, when he set out, or at latest when he spoke with you; and that you agreed.

Seeing that he seldom stayed in the workshop, and that he ate a great deal, I sent him word that, if he liked I could deal with him separately for each thing that he might make, and would give him what we might agree to be a fair valuation. He took counsel with his neighbour and gave up his room, selling every thing, and went to find...

Miscellaneous Records (1354. 1355).

1354.

[Footnote: A puzzling passage, meant, as it would seem, for a jest. Compare the description of Giants in Dante, *Inf.* XXI and XXII. Perhaps Leonardo had the Giant Antaeus in his mind. Of him the myth relates that he was a son of Ge, that he fed on lions; that he hunted in Libya and killed the inhabitants. He enjoyed the peculiarity of renewing his strength whenever he fell and came in contact with his mother earth; but that Hercules lifted him up and so conquered and strangled him. Lucan gives a full account of the struggle. *Pharsalia* IV, 617. The reading of this passage, which is very indistinctly written, is in many places doubtful.]

Dear Benedetto de' Pertarti. When the proud giant fell because of the bloody and miry state of the ground it was as though a mountain had fallen so that the country shook as with an earthquake, and terror fell on Pluto in hell. From the violence of the shock he lay as stunned on the level ground. Suddenly the people, seeing him as one killed by a thunderbolt, turned back; like ants running wildly over the body of the fallen oak, so these rushing over his ample limbs..... them with frequent wounds; by which, the giant being roused and feeling himself almost covered by the multitude, he suddenly perceives the smarting of the stabs, and sent forth a roar which sounded like a terrific clap of thunder; and placing his hands on the ground he raised his terrible face: and having lifted one hand to his head he found it full of men and rabble sticking to it like the minute creatures which not unfrequently are found there; wherefore with a shake of his head he sends the men flying through the air just as hail does when driven by the fury of the winds. Many of these men were found to be dead; stamping with his feet.

And clinging to his hair, and striving to hide in it, they behaved like sailors in a storm, who run up the ropes to lessen the force of the wind [by taking in sail].

News of things from the East.

Be it known to you that in the month of June there appeared a Giant, who came from the Lybian desert... mad with rage like ants.... struck down by the rude.

This great Giant was born in Mount Atlas and was a hero ... and had to fight against the Egyptians and Arabs, Medes and Persians. He lived in the sea on whales, grampuses and ships.

Mars fearing for his life took refuge under the... of Jove.

And at the great fall it seemed as though the whole province quaked.

1355.

This spirit returns to the brain whence it had departed, with a loud voice and with these words, it moved...

And if any man though he may have wisdom or goodness

[Footnote: This passage, very difficult to decipher, is on the reverse of a drawing at Windsor, Pl. CXXII, which possibly has some connection with it. The drawing is slightly reduced in this reproduction; the original being 25 cm. high by 19 cm. wide.]

O blessed and happy spirit whence comest thou? Well have I known this man, much against my will. This one is a receptacle of villainy; he is a perfect heap of the utmost ingratitude combined with every vice. But of what use is it to fatigue myself with vain words? Nothing is to be found in them but every form of sin ... And if there should be found among them any that possesses any good, they will not be treated differently to myself by other men; and in fine, I come to the conclusion that it is bad if they are hostile, and worse if they are friendly.

Miscellaneous drafts of letters and personal records (1356 — 1368).

1356.

All the ills that are or ever were, if they could be set to work by him, would not satisfy the desires of his iniquitous soul; and I could not in any length of time describe his nature to you, but I conclude...

1357.

I know one who, having promised me much, less than my due, being disappointed of his presumptuous desires, has tried to deprive me of all my friends; and as he has found them wise and not pliable to his will, he has menaced me that, having found means of denouncing me, he would deprive me of my benefactors. Hence I have informed your Lordship of this, to the end [that this man who wishes to sow the usual scandals, may find no soil fit for sowing the thoughts and deeds of his evil nature] so that he, trying to make your Lordship, the instrument of his iniquitous and malicious nature may be disappointed of his desire.

1358.

[Footnote: Below this text we read gusstino — Giustino and in another passage on the same page Justin is quoted (No. 1210, 1. 48). The two have however no real connection.]

And in this case I know that I shall make few enemies seeing that no one will believe what I can say of him; for they are but few whom his vices have disgusted, and he only dislikes those men whose natures are contrary to those vices. And many hate their fathers, and break off friendship with those who reprove their vices; and he will not permit any examples against them, nor any advice.

If you meet with any one who is virtuous do not drive him from you; do him honour, so that he may not have to flee from you and be reduced to hiding in hermitages, or caves or other solitary places to escape from your treachery; if there is such an one among you do him honour, for these are our Saints upon earth; these are they who deserve statues from us, and images; but remember that their images are not to be eaten by you, as is still done in some parts of India [Footnote 15: In explanation of this passage I have received the following communication from Dr. G. W. LEITNER of Lahore: “So far as Indian customs are known to us, this practice spoken of by Leonardo as ‘still existing in some parts of India’ is perfectly unknown; and it is equally opposed to the spirit of Hinduism, Mohammedanism and Sikhism. In central Thibet the ashes of the dead, when burnt, are mixed with dough, and small figures — usually of Buddha — are stamped out of them and some are laid in the grave while others are distributed among the relations. The custom spoken of by Leonardo may have prevailed there but I never heard of it.” Possibly Leonardo refers here to customs of nations of America.] where, when the images have according to them, performed some miracle, the priests cut them in pieces, being of wood, and give them to all the people of the country, not without payment; and each one grates his portion very fine, and puts it upon the first food he eats; and thus believes that by faith he has eaten his saint who then preserves him from all perils. What do you think here, Man, of your own species? Are you so wise as you believe yourselves to be? Are these things to be done by men?

1359.

As I told you in past days, you know that I am without any....
Francesco d’Antonio. Bernardo di Maestro Jacopo.

1360.

Tell me how the things happened.

1361.

j lorezo\\ 2 inbiadali\\ 3 inferri de\\ 4in lorezo\\ 5[inno abuil]\\ 6 in
acocatu\\ 7 per la sella\\ 8colte di lor\\ 9v cavallott\\ I0el uiagg\\ I1al\\ I2a
lurez\\ 13in biada\\ 14inferri\\ 15abuss\\ 16in viagg\\ 17alorz\\ [Footnote:
This seems to be the beginning of a letter, but only the first words of the lines
have been preserved, the leaf being torn down the middle. No translation is
possible.]

1362.

And so may it please our great Author that I may demonstrate the nature of
man and his customs, in the way I describe his figure.

[Footnote: A preparatory note for the passage given as No. 798, 11. 41 — 42.]

1363.

This writing distinctly about the kite seems to be my destiny, because among
the first recollections of my infancy, it seemed to me that, as I was in my cradle,
a kite came to me and opened my mouth with its tail, and struck me several
times with its tail inside my lips.

[Footnote: This note probably refers to the text No. 1221.]

1364.

[When I did well, as a boy you used to put me in prison. Now if I do it being
grown up, you will do worse to me.]

1365.

Tell me if anything was ever done.

1366.

Tell me if ever I did a thing which me

1367.

Do not reveal, if liberty is precious to you; my face is the prison of love.

[Footnote: This note seems to be a quotation.]

1368.

Maestro Leonardo of Florence.

[Footnote: So Leonardo writes his name on a sheet with sundry short notes, evidently to try a pen. Compare the signature with those in Nos. 1341, 1348 and 1374 (see also No. 1346, l. 33). The form “Lionardo” does not occur in the autographs. The Portrait of the Master in the Royal Library at Turin, which is reproduced — slightly diminished — on Pl. I, has in the original two lines of writing underneath; one in red chalk of two or three words is partly effaced: *lionardo it... lm* (or *lai?*); the second written in pencil is as follows: *fatto da lui stesso assai vecchio*. In both of these the writing is very like the Master’s, but is certainly only an imitation.]

Notes bearing Dates (1369 — 1378).

1369.

The day of Santa Maria *della Neve* [of the Snows] August the 2nd 1473.
[Footnote: W. An. I. 1368. 1369. This date is on a drawing of a rocky landscape. See *Chronique des Arts* 1881 no. 23: *Leonard de Vinci a-t-il ete au Righi le 5 aout 1473?* letter by H. de Geymuller. The next following date in the MSS. is 1478 (see No. 663).

1370.

On the 2nd of April 1489, book entitled ‘Of the human figure’. [Footnote: While the letters in the MS. notes of 1473 and 1478 are very ornate, this note and the texts on anatomy on the same sheet (for instance No. 805) are in the same simple hand as we see on Pl. CXVI and CXIX. No 1370 is the only dated note of the years between 1480 and 1489, and the characters are in all essential points identical with those that we see in the latest manuscripts written in France

(compare the facsimiles on Pl. CXV and p. 254), so that it is hardly possible to determine exactly the date of a manuscript from the style of the handwriting, if it does not betray the peculiarities of style as displayed in the few notes dated previous to 1480. — Compare the facsimile of the manuscripts 1479 on Pl. LXII, No. 2; No. 664, note, Vol. I p. 346. This shows already a marked simplicity as compared with the calligraphy of 1478.

The text No. 720 belongs to the year 1490; No. 1510 to the year 1492; No. 1459, No. 1384 and No. 1460 to the year 1493; No. 1463, No. 1517, No. 1024, 1025 and 1461 to the year 1494; Nos. 1523 and 1524 to the year 1497.

1371.

On the 1st of August 1499, I wrote here of motion and of weight.

[Footnote: 1371. *Scrissi qui*. Leonardo does not say where; still we may assume that it was not in Milan. Amoretti writes, *Memorie Storiche*, chap. XIX: *Sembra pertanto che non nel 1499 ma nel 1500, dopo il ritorno e la prigionia del duca, sia da qui partito Lionardo per andare a Firenze; ed e quindi probabile, che i mesi di governo nuovo e incerto abbia passati coll' amico suo Francesco Melzi a Vaprio, ove meglio che altrove studiar potea la natura, e soprattutto le acque, e l'Adda specialmente, che gia era stato l'ogetto delle sue idrostatiche ricerche*. At that time Melzi was only six years of age. The next date is 1502; to this year belong No. 1034, 1040, 1042, 1048 and 1053. The note No. 1525 belongs to the year 1503.]

1372.

On the 9th of July 1504, Wednesday, at seven o'clock, died Ser Piero da Vinci, notary at the Palazzo del Podesta, my father, — at seven o'clock, being eighty years old, leaving behind ten sons and two daughters.

[Footnote: This statement of Ser Piero's age contradicts that of the *Riassunto della portata di Antonio da Vinci* (Leonardo's grandfather), who speaks of Ser Piero as being thirty years old in 1457; and that of the *Riassunto della portata di Ser Piero e Francesco*, sons of Antonia da Vinci, where Ser Piero is mentioned as being forty in 1469. These documents were published by G. UZIELLI, *Ricerche intorno a L. da Vinci*, Firenze, 1872, pp. 144 and 146. Leonardo was, as is well known, a natural son. His mother 'La Catarina' was married in 1457 to Acchatabriga di Piero del Vaccha da Vinci. She died in 1519. Leonardo never mentions her in the Manuscripts. In the year of Leonardo's birth Ser Piero

married Albiera di Giovanni Amadoci, and after her death at the age of thirty eight he again married, Francesca, daughter of Ser Giovanni Lanfredi, then only fifteen. Their children were Leonardo's halfbrothers, Antonio (b. 1476), Ser Giuliano (b. 1479), Lorenzo (b. 1484), a girl, Violante (b. 1485), and another boy Domenico (b. 1486); Domenico's descendants still exist as a family. Ser Piero married for the third time Lucrezia di Guglielmo Cortigiani by whom he had six children: Margherita (b. 1491), Benedetto (b. 1492), Pandolfo (b. 1494), Guglielmo (b. 1496), Bartolommeo (b. 1497), and Giovanni (date of birth unknown). Pierino da Vinci the sculptor (about 1520-1554) was the son of Bartolommeo, the fifth of these children. The dates of their deaths are not known, but we may infer from the above passage that they were all still living in 1505.]

1373.

On Wednesday at seven o'clock died Ser Piero da Vinci on the 9th of July 1504.

[Footnote: This and the previous text it may be remarked are the only mention made by Leonardo of his father; Nos. 1526, 1527 and No. 1463 are of the year 1504.]

1374.

Begun by me, Leonardo da Vinci, on the 12th of July 1505.

[Footnote: Thus he writes on the first page of the MS. The title is on the foregoing coversheet as follows: *Libro titolato disstrafformatione coe* (cioe) *d'un corpo nvn* (in un) *altro senza diminuitione e acresscemento di materia.*]

1375.

Begun at Milan on the 12th of September 1508.

[Footnote: No. 1528 and No. 1529 belong to the same year. The text Vol. I, No. 4 belongs to the following year 1509 (1508 old style); so also does No. 1009. — Nos. 1022, 1057 and 1464 belong to 1511.]

1376.

On the 9th of January 1513.

[Footnote: No. 1465 belongs to the same year. No. 1065 has the next date 1514.]

1377.

The Magnifico Giuliano de' Medici left Rome on the 9th of January 1515, just at daybreak, to take a wife in Savoy; and on the same day fell the death of the king of France.

[Footnote: Giuliano de Medici, brother to Pope Leo X.; see note to Nos. 1351-1353. In February, 1515, he was married to Filiberta, daughter of Filippo, Duke of Savoy, and aunt to Francis I, Louis XII's successor on the throne of France. Louis XII died on Jan. 1st, and not on Jan. 9th as is here stated. — This addition is written in paler ink and evidently at a later date.]

1378.

On the 24th of June, St John's day, 1518 at Amboise, in the palace of...

[Footnote: *Castello del clli*. The meaning of this word is obscure; it is perhaps not written at full length.]

THOUGHTS ON ART AND LIFE



Translated by Maurice Baring

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INTRODUCTION

The long obscurity of the Dark Ages lifted over Italy, awakening to a national though a divided consciousness. Already two distinct tendencies were apparent. The practical and rational, on the one hand, was soon to be outwardly reflected in the burgher-life of Florence and the Lombard cities, while at Rome it had even then created the civil organization of the curia. The novella was its literary triumph. In art it expressed itself simply, directly and with vigour. Opposed to this was the other great undercurrent in Italian life, mystical, religious and speculative, which had run through the nation from the earliest times, and received fresh volume from mediaeval Christianity, encouraging ecstatic mysticism to drive to frenzy the population of its mountain cities. Umbrian painting is inspired by it, and the glowing words of Jacopone da Todi expressed in poetry the same religious fervour which the life of Florence and Perugia bore witness to in action.

Italy developed out of the relation and conflict of these two forces the rational with the mystical. Their later union in the greater men was to form the art temperament of the Renaissance. The practical side gave it the firm foundation of rationalism and reality on which it rested; the mystical guided its endeavour to picture the unreal in terms of ideal beauty.

The first offspring of this union was Leonardo. Since the decay of ancient art no painter had been able to fully express the human form, for imperfect mastery of technique still proved the barrier. Leonardo was the first completely to disengage his personality from its constraint, and make line express thought as none before him could do. Nor was this his only triumph, but rather the foundation on which further achievement rested. Remarkable as a thinker alone, he preferred to enlist thought in the service of art, and make art the handmaid of beauty. Leonardo saw the world not as it is, but as he himself was. He viewed it through the atmosphere of beauty which filled his mind, and tinged its shadows with the mystery of his nature. To all this, his birthright as a painter, a different element was added. A keen desire for knowledge, guiding his action in life, spurred him onward. Conscious of this dominant impulse, he has fancifully described himself in a Platonic allegory. He had passed beneath overhanging cliffs on his way to a great cavern. On bended knees, peering through its darkness, fear and desire had overwhelmed him, — fear for the menacing darkness of the cavern; and desire to ascertain if there were wonders therein.

From his earliest years, the elements of greatness were present in Leonardo. But the maturity of his genius came unaffected from without. He barely noticed the great forces of the age which in life he encountered. After the first promise of his boyhood in the Tuscan hills, his youth at Florence had been spent under Verrocchio as a master, in company with those whose names were later to brighten the pages of Italian art. He must then have heard Savonarola's impassioned sermons, yet, unlike Botticelli, remained dumb to his entreaties. He must have seen Lorenzo the Magnificent. But there was little opening in the Medicean circle for the young painter, who had first to gain fame abroad. The splendour of Milan under Il Moro, then the most brilliant court in Europe, attracted him. He went there, proclaiming his ability, in a remarkable letter, to accomplish much, but desiring chiefly to erect a great monument to the glory of the Sforza. He spent years at that court, taken up by his different ventures, — painting, sculpture, engineering, even arranging festivities — but his greater project was doomed to failure, enmeshed in the downfall of Ludovico. Even to this he remained impassive. "Visconti dragged to prison, his son dead, ... the duke has lost his state, his possessions, his liberty, and has finished nothing he undertook," was his only comment on his patron's end, written on the margin of a manuscript. After the overthrow of the Duke of Milan, began his Italian wanderings. At one time he contemplated entering the service of an Oriental prince. Instead, he entered that of Caesar Borgia, as military engineer, and the greatest painter of the age became inspector of a despot's strongholds. But his restless nature did not leave him long at this. Returning to Florence he competed with Michelangelo; yet the service of even his native city could not retain him. His fame had attracted the attention of a new patron of the arts, prince of the state which had conquered his first master. In this his last venture, he forsook Italy, only to die three years later at Amboise, in the castle of the French king.

The inner nature of Leonardo remained as untouched by the men he encountered as by the events which were then stirring Europe. Alone, he influenced others, remaining the while a mystery to all. The most gifted of nations failed to understand the greatest of her sons. Isabella d'Este, the first lady of her time, seeking vainly to obtain some product of his brush, was told that his life was changeful and uncertain, that he lived for the day, intent only on his art. His own thoughts reveal him in another light. "I wish to work miracles," he wrote. And elsewhere he exclaimed, "Thou, O God, sellest us all benefits, at the cost of our toil.... As a day well spent makes sleep seem pleasant, so a life well employed makes death pleasant. A life well spent is long."

Leonardo's views of aesthetic are all important in his philosophy of life and

art. The worker's thoughts on his craft are always of interest. They are doubly so when there is in them no trace of literary self-consciousness to blemish their expression. He recorded these thoughts at the instant of their birth, for a constant habit of observation and analysis had early developed with him into a second nature. His ideas were penned in the same fragmentary way as they presented themselves to his mind, perhaps with no intention of publishing them to the world. But his ideal of art depended intimately, none the less, on the system he had thrown out seemingly in so haphazard a manner. His method gives to his writings their only unity. It was more than a method: it was a permanent expression of his own life, which aided him to construct a philosophy of beauty characteristic of the new age.

He had searched to find a scientific basis for art, and discovered it in the imitation of nature, based on rational experience. This idea was, in part, Aristotelian, imbibed with the spirit of the time; though in the ordinary acceptance of the word Leonardo was no scholar, least of all a humanist. His own innovation in aesthetic was in requiring a rational and critical experience as a necessary foundation, the acquisition of which was to result from the permanent condition of the mind. He had trained his own faculties to critically observe all natural phenomena: first try by experience, and then demonstrate why such experiment is forced to operate in the way it does, was his advice. The eye, he gave as an instance, had been defined as one thing; by experience, he had found it to be another.

But by imitation in art, Leonardo intended no slavish reproduction of nature. When he wrote that "the painter strives and competes with nature," he was on the track of a more Aristotelian idea. This he barely developed, using nature only partly in the Stagirite's sense, of inner force outwardly exemplified. The idea of imitation, in fact, as it presented itself to his mind, was two-fold. It was not merely the external reproduction of the image, which was easy enough to secure. The real difficulty of the artist lay in reflecting inner character and personality. It was Leonardo's firm conviction that each thought had some outward expression by which the trained observer was able to recognize it. Every man, he wrote, has as many movements of the body as of varieties of ideas. Thought, moreover, expressed itself outwardly in proportion to its power over the individual and his time of life. By thus employing bodily gesture to represent feeling and idea, the painter could affect the spectator whom he placed in the presence of visible emotion. He maintained that art was of slight use unless able to show what its subject had in mind. Painting should aim, therefore, to reproduce the inner mental state by the attitude assumed. This was, in other words, a natural symbolism, in which the symbol was no mere convention, but the actual outward

projection of the inner condition of the mind. Art here offered an equation of inward purpose and outward expression, neither complete without the other.

Further than this, influenced by Platonic thought, Leonardo's conception of painting was, as an intellectual state or condition, outwardly projected. The painter who practised his art without reasoning of its nature was like a mirror unconsciously reflecting what was before it. Although without a "manual act" painting could not be realized, its true problems — problems of light, of colour, pose and composition, of primitive and derivative shadow — had all to be grasped by the mind without bodily labour. Beyond this, the scientific foundation in art came through making it rest upon an accurate knowledge of nature. Even experience was only a step towards attaining this. "There is nothing in all nature without its reason," he wrote. "If you know the reason, you do not need the experience."

In the history of art, as well, he urged that nature had been the test of its excellence. A natural phenomenon had brought art into existence. The first picture in the world, he remarked in a happy epigram, had been "a line surrounding the shadow of a man, cast by the sun on the wall." He traced the history of painting in Italy during its stagnation after the decay of ancient art, when each painter copied only his predecessor, which lasted until Giotto, born among barren mountains, drew the movements of the goats he tended, and thus advanced farther than all the earlier masters. But his successors only copied him, and painting sank again until Masaccio once more took nature as his guide.

A quite different and combative side to Leonardo's aesthetic, which forced him to state the broad principles of art, appears in his attacks on poetry and music as inferior to painting. In that age of humanistic triumph, literature had lorded it over the other arts in a manner not free from arrogance. There was still another cause for his onslaught on poetry. Leonardo resented the fact that painters, who were rarely men of education, had not defended themselves against the slurs cast on their art. His counter attack may have been intended to hide his own small scholarship. It served another end as well. His conception of the universal principles of beauty was made clear by this defence. His first principle stated broadly that the most useful art was the one which could most easily be communicated. Painting was communicable to all since its appeal was made to the eye. While the painter proceeded at once to the imitation of nature, the poet's instruments were words which varied in every land. He took the Platonic view of poetry as a lying imitation, removed from truth. He called the poet a collector of other men's wares, who decked himself in their plumage. Where poetry presented only a shadow to the imagination, painting offered a real image to the eye; and the eye, as the window of the soul through which all

earthly beauty was revealed, the sight, he exclaimed, which had discovered navigation, which had impelled men to seek the West, was the noblest of all the senses. Painting spoke only by what it accomplished, poetry ended in the very words with which it sang its own praises. If, then, poets called painting dumb poetry, he could retort by dubbing poetry blind painting. In common with his successors, Leonardo could not escape from this fallacy, which, in overlooking all save descriptive verse, was destined to burden aesthetic until demolished by Lessing.

It was the opinion of Leonardo that the temporary nature of music caused its inferiority to painting. Although durability was in itself no absolute test, — else the work of coppersmiths would be the highest art, — yet in any final scale, permanence could not altogether be disregarded. Music perished in the very act of its creation, while painting preserved the beautiful from the hand of time. “Helen of Troy, gazing in a mirror, in her old age, wondered how she had twice been ravished.” Mortal beauty would thus vanish, if it were not rescued by art from destroying age and death.

Leonardo contrasted painting with sculpture, for he had practised both, and thought himself peculiarly qualified to judge their merit. He considered the former the nobler art of the two, for sculpture involved bodily toil and fatigue, while by its very nature it lacked perspective and atmosphere, colour, and the feeling of space. Painting, on the other hand, caused by an illusion, was in itself the result of deeper thought. An even broader test served to convince him of its final superiority. That art was of highest excellence, he wrote, which possessed most elements of variety and universality. Painting contained and reproduced all forms of nature; it made its appeal by the harmonious balance of parts which gratified all the senses. By its very duality it fulfilled the highest purpose. The painter was able to visualize the beauty which enchanted him, to bring to reality the fancy of his dreams, and give outward expression to the ideal within.

The genius of Leonardo as a painter came through unfolding the mystery of life. Like Miranda, he had gazed with wonder at the beauty of the world. “Look at the grace and sweetness of men and women in the street,” he wrote. The most ordinary functions of life and nature amazed him most. He observed of the eye how in its form and colour, and the entire universe it reflected, were reduced to a single point. “Wonderful law of nature, which forced all effects to participate with their cause in the mind of man. These are the true miracles!” Elsewhere he wrote again: “Nature is full of infinite reasons which have not yet passed into experience.” He conceived it to be the painter’s duty not only to comment on natural phenomena as restrained by law, but to merge his very mind into that of nature by interpreting its relation with art. Resting securely on the reality of

experienced truth, he felt the deeper presence of the unreal on every side. In the same way that he visualized the inner workings of the mind, his keen imagination aided him to make outward trifles serve his desire to find mysterious beauty everywhere. Oftentimes, in gazing on some ancient, time-stained wall, he describes how he would trace thereon landscapes, with mountains, rivers and valleys. The whole world was full of a mystery to him, which his work reflected. The smile of consciousness, pregnant of that which is beyond, illumines the expression of Mona Lisa. So, too, in the strange glance of Ann, of John the Baptist, and of the Virgin of the Rocks, one realizes that their thoughts dwell in another world.

Leonardo had found a refuge in art from the pettiness of material environment. Like his own creations, he, too, had learned the secret of the inner life. The painter, he wrote, could create a world of his own, and take refuge in this new realm. But it must not be one of shadows only. The very mystery he felt so keenly had yet to rest on a real foundation; to treat it otherwise would be to plunge into mere vapouring. Although attempting to bridge the gulf which separated the real from the unreal, he refused to treat the latter supernaturally. That mystery which lesser minds found in the occult, he saw in nature all about him. He denied the existence of spirits, just as he urged the foolishness of the will-o'-the-wisps of former ages, — alchemy and the black art. In one sentence he destroyed the pretensions of palmistry. "You will see," he wrote, "great armies slaughtered in an hour's time, where in each individual the signs of the hands are different."

His art took, thus, its guidance in realism, its purpose in spirituality. The search for truth and the desire for beauty were the twin ideals he strove to attain. The keenness of this pursuit saved him from the blemish of egoism which aloofness from his surroundings would otherwise have forced upon him. For his character presented the anomaly, peculiar to the Renaissance, of a lofty idealism coupled in action with irresponsibility of duty. He stood on a higher plane, his attitude toward life recognizing no claims on the part of his fellowmen. In his desire to surpass himself, fostered by this isolation of spirit and spurred on by the eager wish to attain universal knowledge, he has been compared to Faust; but the likeness is only half correct. He was not blind to the limitations which encompassed him, his very genius making him realize their bounds. Of the ancients he said that in attempting to define the nature of the soul, they sought the impossible. He wrote elsewhere, "It is the infinite alone that cannot be attained, for if it could it would become finite."

In Leonardo's personality was reflected both the strength and weakness of Renaissance Italy. So, to know him, it is necessary to understand the Italy of that

age. Its brilliancy, its universality, its desire for beauty, are but one side of the medal. On its reverse, Italy lacked the solid vigour of a national purpose. The discord of political disunion, reacting on art, laid bare great weakness in the want of any constructive direction, toward which the strength of the Renaissance could aim. The energy was there, whether finding an outlet in statecraft or in discovery, in art or in letters. But it laboured for no common end; there was internal unity of force and method, but external divergence of purpose. The tyranny of petty despots could provide no adequate ideal toward which to aim. No ruler, and no city save Venice, could long symbolize the nation's patriotism. Venetian painters alone glorified the state in their work, and thus felt the living force of a national ambition which raised them above themselves. But elsewhere there was little to inspire that devotion for a common country necessary as a background to sustain the greatest work. Hence Italian art, so living within certain limits, remained stunted beyond these. The conviction that art existed in order to express ideal beauty, that its main purpose was to please the eye and the senses in spite of the result attained, proved inadequate compensation for all that had been withdrawn. The art ideal tended more and more to become a conscience and a purpose in itself, an inward impulse for action and an outward goal.

The artist's real greatness will depend at all times on his qualities as a representative. His true merit will arise from giving expression in ideal terms to his nation and to his age. In so far as he has been able to do this and the spirit of his country is reflected in his work, in so far as he has represented what is best therein and most enduring, he will have achieved greatness. Not that this is always, or even often, a conscious expression. It is unfair reading to search for deep thought in the work of either painter or poet. Neither art offers the best medium to convey the abstractions of the mind, since each has its own method of expression, independent of pure reason. But painter and poet, in the degree they attain greatness, express more than themselves. Ariosto, intent only to amuse, reflects with playful wit and skepticism the splendid luxury and joy of living in Renaissance court life. The care with which he chiselled each line proves that his real seriousness and conscience lay in his artistic purpose. Without Ariosto's wit, Paolo Veronese depicted a similar side in painting, though his Venetian birthright made him celebrate the glory of the Republic. Poet and painter alike expressed far more than either could know. If such a test be applied to the artists of the Renaissance, each in turn will respond to it, — just as the weakness of the later Bolognese as a school is that, beyond a certain technical merit, they meant and represented so little. But the noblest painters, —

Michelangelo and Raphael, Titian and Leonardo, — in addition to possessing the solid grasp of technical mastery, reflected some aspect of their nation's life and civilization. In Michelangelo was realized the grandeur of Italy struggling vainly against crushing oppression. He expressed that which was highest in it, reflecting the loftiest side of its idealism mingled with deep pessimism in his survey over life; for, wrapped in austerity, he saw mankind in heroic terms of sadness. Raphael, on the other hand, found only beautiful sweetness everywhere. The tragedies of life failed to touch the young painter, who blotted from view all struggle and sorrow, and, in spite of the misery which had befallen his nation, could still rejoice in the sensuous beauty of the world. There was another side to the Renaissance, dependent neither on beauty nor heroic grandeur, yet sharing in both through qualities of its own. Titian, who painted the living man of action, the man of parts, susceptible alike to the appreciation of ideal beauty and heroic impulse, but guided withal by expediency, reflected this more practical aspect of life. In his portraiture he expressed the statecraft for which Italians found opportunity beyond the Alps, since in Italy it was denied them; and Titian found even Venice too narrow for the scope of his art.

But before Titian, before Raphael, before Michelangelo, Leonardo reflected the rationalism and the mystery, the subtlety and the philosophical speculation, of the age. To find in his work only the individual thought of genius would be to mistake, perhaps, its most important side; for the expression of his mind, both by its brilliancy and its limitations, is typical of the spirit of his time. The Italian Renaissance was reflected in him as rarely a period has been expressed in the life-work of a single man. He represented its union of practice and theory, of thought placed in the service of action. He summed up its different aspects in his own individuality. Intellectually, he represented its many-sidedness attained through penetration of thought, and a keenness of observation, profiting from experience, extended into every sphere. As an artist he possessed a vigour of imagination from which sprang his power of creating beauty. But, in spite of his practical nature, he remained a dreamer in an age which had in it more of stern reality than of golden dreams. His very limitations, his excess of individualism, his want of long-continued concentration, his lack of patriotism, his feeling of the superiority of art to nationality, are all characteristic of Renaissance Italy.

The union in Leonardo of reality to mystery has often been shared by genius in other fields. His own peculiar greatness sprang from expressing in art the apparent contradiction of attaining the world of mystery through force of reality. Like Hamlet, it was the union of the real with the unreal which appealed to him, of the world as he saw it and the world as he imagined it to be. It was but another expression of the eternal ideal of truth and beauty.

L. E.
American Embassy London, 1906

I. THOUGHTS ON LIFE

Begun at Florence in the house of Piero di Braccio Martelli, on the 22d day of March, 1508; and this is to be a collection without order, taken from many papers which I have copied here, hoping to arrange them later, each in its place, according to the various subjects treated. And I think that before I shall have finished this work, it will be necessary for me to repeat the same thing many times over; so, O reader, blame me not, because the subjects are many, and memory cannot retain them and say: This I will not write because I have already written it; and if I did not wish to fall into this error it would be necessary, every time that I wished to copy something, in order not to repeat myself, to read over all the preceding matter, all the more so since the intervals are long between one time of writing and another.

His Thirst after Knowledge

2.

Not louder does the tempestuous sea bellow when the north wind strikes its foaming waves between Scylla and Charybdis; nor Stromboli nor Mount Etna when the sulphurous flames, shattering and bursting open the great mountain with violence, hurl stones and earth through the air with the flame it vomits; nor when the fiery caverns of Mount Etna, spitting forth the element which it cannot restrain, hurl it back to the place whence it issued, driving furiously before it any obstacle in the way of its vehement fury ... so I, urged by my great desire and longing to see the blending of strange and various shapes made by creating nature, wandered for some time among the dark rocks, and came to the entrance of a great cave, in front of which I long stood in astonishment and ignorance of such a thing. I bent my back into an arch and rested my left hand on my knee, and with my right hand shaded my downcast eyes and contracted eyebrows. I bent down first on one side and then on the other to see whether I could perceive anything, but the thick darkness rendered this impossible; and after having remained there some time, two things arose within me, fear and desire, — fear of the dark and threatening cave, desire to see whether there were anything marvellous within.

3.

I discover for man the origin of the first and perhaps of the second cause of his being.

Leonardo's Studies

4.

Recognizing as I do that I cannot make use of subject matter which is useful and delightful, since my predecessors have exhausted the useful and necessary themes, I shall do as the man who by reason of his poverty arrives last at the fair, and cannot do otherwise than purchase what has already been seen by others and not accepted, but rejected by them as being of little value. I shall place this despised and rejected merchandise, which remains over after many have bought, on my poor pack, and I shall go and distribute it, not in the big cities, but in the poor towns, and take such reward as my goods deserve.

Vain Knowledge

5.

All knowledge which ends in words will die as quickly as it came to life, with the exception of the written word: which is its mechanical part.

6.

Avoid studies the result of which will die together with him who studied.

Value of Knowledge

7.

The intellect will always profit by the acquisition of any knowledge

whatsoever, for thus what is useless will be expelled from it, and what is fruitful will remain. It is impossible either to hate or to love a thing without first acquiring knowledge of it.

8.

Men of worth naturally desire knowledge.

9.

It is ordained that to the ambitious, who derive no satisfaction from the gifts of life and the beauty of the world, life shall be a cause of suffering, and they shall possess neither the profit nor the beauty of the world.

On his Contemners

10.

I know that many will say that this work is useless, and these are they of whom Demetrius said recked no more of the breath which made the words proceed from their mouth, than of the wind which proceeded from their body, — men who seek solely after riches and bodily satisfaction, men entirely denuded of that wisdom which is the food and verily the wealth of the soul; because insomuch as the soul is of greater value than the body, so much greater are the riches of the soul than those of the body. And often when I see one of these take this work in his hand, I wonder whether, like a monkey, he will not smell it and ask me if it is something to eat.

On the Vulgar

11.

Demetrius used to say that there was no difference between the words and the voice of the unskilled ignorant and the sounds and noises of a stomach full of superfluous wind. And it was not without reason that he said this, for he considered it to be indifferent whence the utterance of such men proceeded, whether from their mouth or their body; both being of the same substance and value.

12.

I do not consider that men of coarse and boorish habits and of slender parts deserve so fine an instrument nor such a complicated mechanism as men of contemplation and high culture. They merely need a sack in which their food may be held and whence it may issue, since verily they cannot be considered otherwise than as vehicles for food, for they seem to me to have nothing in common with the human race save the shape and the voice; as far as the rest is concerned they are lower than the beasts.

13.

Knowledge of the past and of the places of the earth is the ornament and food of the mind of man.

Knowledge the supreme Good

14.

Cornelius Celsus: Knowledge is the supreme good, the supreme evil is physical pain. We are composed of two separate parts, the soul and the the body; the soul is the greater of these two, the body the lesser. Knowledge appertains to the greater part, the supreme evil belongs to the lesser and baser part. Knowledge is an excellent thing for the mind, and pain is the most grievous thing for the body. Just as the supreme evil is physical pain, so is wisdom the supreme good of the soul, that is to say of the wise man, and no other thing can be compared with it.

Life and Wisdom

15.

In the days of thy youth seek to obtain that which shall compensate the losses of thy old age. And if thou understandest that old age is fed with wisdom, so conduct thyself in the days of thy youth that sustenance may not be lacking to thy old age.

Praise of Knowledge

16.

The fame of the rich man dies with him; the fame of the treasure, and not of the man who possessed it, remains. Far greater is the glory of the virtue of mortals than that of their riches. How many emperors and how many princes have lived and died and no record of them remains, and they only sought to gain dominions and riches in order that their fame might be ever-lasting. How many were those who lived in scarcity of worldly goods in order to grow rich in virtue; and as far as virtue exceeds wealth, even in the same degree the desire of the poor man proved more fruitful than that of the rich man. Dost thou not see that wealth in itself confers no honour on him who amasses it, which shall last when he is dead, as does knowledge? — knowledge which shall always bear witness like a clarion to its creator, since knowledge is the daughter of its creator, and not the stepdaughter, like wealth.

The World

17.

Bountiful nature has provided that in all parts of the world you will find something to imitate.

18.

The Beauty of Life

Consider in the streets at nightfall the faces of men and women when it is bad weather, what grace and sweetness they manifest!

19.

Just as iron which is not used grows rusty, and water putrefies and freezes in the cold, so the mind of which no use is made is spoilt.

Fruitless Study

20.

Just as food eaten without appetite is a tedious nourishment, so does study without zeal damage the memory by not assimilating what it absorbs.

21.

Truth was the only daughter of time.

In Praise of Truth

22.

So vile a thing is a lie that even if it spoke fairly of God it would take away somewhat from His divinity; and so excellent a thing is truth that if it praises the humblest things they are exalted. There is no doubt that truth is to falsehood as light is to darkness; and so excellent a thing is truth that even when it touches humble and lowly matters, it still incomparably exceeds the uncertainty and falsehood in which great and elevated discourses are clothed; because even if falsehood be the fifth element of our minds, notwithstanding this, truth is the supreme nourishment of the higher intellects, though not of disorderly minds. But thou who feedest on dreams dost prefer the sophistry and subterfuges in

matters of importance and uncertainty to what is certain and natural, though of lesser magnitude.

23.

Obstacles in the way of truth are finally punished.

Versus Humanists

24.

I am well aware that not being a literary man the presumptuous will think that they have the right to blame me on the ground that I am not a man of letters. Vainglorious people! Know they not that I could make answer as Marius did to the Roman people, and say: They who make a display with the labours of others will not allow me mine? They will say that being unskilled in letters I cannot find true expression for the matters of which I desire to treat; they do not know that in my subjects experience is a truer guide than the words of others, for experience was the teacher of all great writers, and therefore I take her for guide, and I will cite her in all cases.

25.

Although I may not be able to quote other authors, as they do, I can quote from a greater and more worthy source, namely, experience, — the teacher of their masters. They go about swelled with pride and pomposity, dressed up and bedight, not with their own labour, but with that of others; and they will not concede me mine. And if they despise me, who am a creator, far more are they, who do not create but trumpet abroad and exploit the works of other men, to be blamed.

Authority

26.

He who in reasoning cites authority is making use of his memory rather than of his intellect.

On Commentators

27.

Men who are creators and interpreters of nature to man, in comparison with boasters and exploiters of the works of others, must be judged and esteemed like the object before the mirror as compared with its image reflected in the mirror. — one being something in itself, and the other nothing. Little to nature do they owe, since it is merely by chance they wear the human form, and but for it I might include them with herds of cattle.

28.

A well lettered man is so because he is well natured, and just as the cause is more admirable than the effect, so is a good disposition, unlettered, more praiseworthy than a well lettered man who is without natural disposition.

29.

Against certain commentators who disparage the inventors of antiquity, the originators of science and grammar, and who attack the creators of antiquity; and because they through laziness and the convenience of books have not been able to create, they attack their masters with false reasoning.

30.

It is better to imitate ancient than modern work.

Experience

31.

Wisdom is the daughter of experience.

Experience never Errs

32.

Wrongly men complain of experience, which with great railing they accuse of falsehood. Leave experience alone, and turn your lamentation to your ignorance, which leads you, with your vain and foolish desires, to promise yourselves those things which are not in her power to confer, and to accuse her of falsehood. Wrongly men complain of innocent experience, when they accuse her not seldom of false and lying demonstrations.

33.

Experience never errs; it is only your judgements that err, ye who look to her for effects which our experiments cannot produce. Because given a principle, that which ensues from it is necessarily the true consequence of that principle, unless it be impeded. Should there, however, be any obstacle, the effect which should ensue from the aforesaid principle will participate in the impediment as much or as little as the impediment is operative in regard to the aforesaid principle.

34.

Experience, the interpreter between creative nature and the human race, teaches the action of nature among mortals: how under the constraint of necessity she cannot act otherwise than as reason, who steers her helm, teaches her to act.

35.

All our knowledge is the offspring of our perceptions.

Origin of Knowledge

36.

The sense ministers to the soul, and not the soul sense; and where the sense which ministers ceases to serve the soul, all the functions of that sense are lacking in life, as is evident in those who are born dumb and blind.

Testimony of the Senses

37.

And if thou sayest that sight impedes the security and subtlety of mental meditation, by reason of which we penetrate into divine knowledge, and that this impediment drove a philosopher to deprive himself of his sight, I answer that the eye, as lord of the senses, performs its duty in being an impediment to the confusion and lies of that which is not science but discourse, by which with much noise and gesticulation argument is constantly conducted; and hearing should do the same, feeling, as it does, the offence more keenly, because it seeks after harmony which devolves on all the senses. And if this philosopher deprived himself of his sight to get rid of the obstacle to his discourses, consider that his discourses and his brain were a party to the act, because the whole was madness. Now could he not have closed his eyes when this frenzy came upon him, and have kept them closed until the frenzy consumed itself? But the man was mad, the discourse insane, and egregious the folly of destroying his eyesight.

Judgement prone to Error

38.

There is nothing which deceives us as much as our own judgement.

39.

The greatest deception which men incur proceeds from their opinions.

40.

Avoid the precepts of those thinkers whose reasoning is not confirmed by experience.

Intelligence of Animals

41.

Man discourseth greatly, and his discourse is for the greater part empty and false; the discourse of animals is small, but useful and true: slender certainty is better than portentous falsehood.

42.

What is an element? It is not in man's power to define the quiddity of the elements, but a great many of their effects are known.

43.

That which is divisible in fact is divisible in potentiality also; but not all quantities which are divisible in potentiality are divisible in fact.

Infinity incomprehensible

44.

What is that thing which is not defined and would not exist if it were defined? It is infinity, which if it could be defined would be limited and finite, because that which can be defined ends with the limits of its circumference, and that which cannot be defined has no limits.

45.

O contemplators of things, do not pride yourselves for knowing those things which nature by herself and her ordination naturally conduces; but rejoice in knowing the purposes of those things which are determined by your mind.

Insoluble Questions

46.

Consider, O reader, how far we can lend credence to the ancients who strove to define the soul and life, — things which cannot be proved; while those things which can be clearly known and proved by experience remained during so many centuries ignored and misrepresented! The eye, which so clearly demonstrates its functions, has been up to my time defined in one manner by countless authorities; I by experience have discovered another definition.

Beauty of Nature's Inventions

47.

Although human ingenuity may devise various inventions which, by the help of various instruments, answer to one and the same purpose, yet will it never discover any inventions more beautiful, more simple or more practical than those of nature, because in her inventions there is nothing lacking and nothing superfluous; and she makes use of no counterpoise when she constructs the limbs of animals in such a way as to correspond to the motion of their bodies,

but she puts into them the soul of the body. This is not the proper place for this discourse, which belongs rather to the subject of the composition of animated bodies; and the rest of the definition of the soul I leave to the minds of the friars, the fathers of the people, who know all secrets by inspiration. I leave the sacred books alone, because they are the supreme truth.

Completeness in Knowledge

48.

Those who seek to abbreviate studies do injury to knowledge and to love because the love of anything is the daughter of this knowledge. The fervency of the love increases in proportion to the certainty of the knowledge, and the certainty issues from a complete knowledge of all the parts, which united compose the totality of the thing which ought to be loved. Of what value, then, is he who abbreviates the details of those matters of which he professes to render a complete account, while he leaves behind the chief part of the things of which the whole is composed? It is true that impatience, the mother of stupidity, praises brevity, as if such persons had not life long enough to enable them to acquire a complete knowledge of one subject such as the human body! And then they seek to comprehend the mind of God, in which the universe is included, weighing it and splitting it into infinite particles, as if they had to dissect it!

O human folly! dost thou not perceive that thou hast been with thyself all thy life, and thou art not yet aware of the thing which more fully than any other thing thou dost possess, namely, thy own folly? And thou desirest with the multitude of sophists to deceive thyself and others, despising the mathematical sciences in which truth dwells and the knowledge of the things which they contain; and then thou dost busy thyself with miracles, and writest that thou hast attained to the knowledge of those things which the human mind cannot comprehend, which cannot be proved by any instance in nature, and thou deemest that thou hast wrought a miracle in spoiling the work of some speculative mind; and thou perceivest not that thy error is the same as that of a man who strips a plant of the ornament of its branches covered with leaves, mingled with fragrant flowers and fruits. Just as Justinus did when he abridged the stories written by Trogus Pompeius, who had written elaborately the noble deeds of his forefathers, which were full of wonderful beauties of style; and thus he composed a barren work, worthy only of the impatient spirits who deem that they are wasting the time which they might usefully employ in studying the

works of nature and mortal affairs. But let such men remain in company with the beasts; let dogs and other animals full of rapine be their courtiers, and let them be accompanied with these running ever at their heels! and let the harmless animals follow, which in the season of the snows come to the houses begging alms as from their master.

Nature

49.

Nature is full of infinite causes which are beyond the pale of experience.

50.

Nature in creating first gives size to the abode of the intellect (the skull, the head), and then to the abode of the vital spirit (the chest).

Law of Necessity

51.

Necessity is the mistress and guide of nature. Necessity is the theme and inventress of nature, her curb and her eternal law.

52.

When anything is the cause of any other thing, and brings about by its movement any effect, the movement of the effect necessarily follows the movement of the cause.

Of Lightning in the Clouds

53.

O mighty and once living instrument of creative nature, unable to avail thyself of thy great strength thou must needs abandon a life of tranquillity and obey the law which God and time gave to Nature the mother. Ah! how often the frightened shoals of dolphins and great tunny fish were seen fleeing before thy inhuman wrath; whilst thou, fulminating with swift beating of wings and twisted tail, raised in the sea a sudden storm with buffeting and sinking of ships and tossing of waves, filling the naked shores with terrified and distracted fishes.

The Human Eye

54.

Since the eye is the window of the soul, the soul is always fearful of losing it, so much so that if a man is suddenly frightened by the motion or an object before him, he does not with his hands protect his heart, the source of all life; nor his head, where dwells the lord of the senses; nor the organs of hearing, smell and taste. But as soon as he feels fright it does not suffice him to close the lids of his eyes, keeping them shut with all his might, but he instantly turns in the opposite direction; and still not feeling secure he covers his eyes with one hand, stretching out the other to ward off the danger in the direction in which he suspects it to lie. Nature again has ordained that the eye of man shall close of itself, so that remaining during his sleep without protection it shall suffer no hurt.

Universal Law

55.

Every object naturally seeks to maintain itself in itself.

56.

The part always tends to reunite with its whole in order to escape from its imperfection; the soul desires to remain with its body, because without the organic instruments of that body it can neither act nor feel.

57.

The lover is moved by the object he loves as the senses are by sensible things; and they unite and become one and the same. The work is the first thing which is born of this union; if the thing loved is base, the lover becomes base. When what is united is in harmony with that which receives it, delight, pleasure and satisfaction ensue. When the lover is united to the beloved he rests there; when the burden is laid down it finds rest there.

58.

A natural action is accomplished in the briefest manner.

Nature Variable and Infinite.

59.

To such an extent does nature delight and abound in variety that among her trees there is not one plant to be found which is exactly like another; and not only among the plants, but among the boughs, the leaves and the fruits, you will not find one which is exactly similar to another.

60.

If nature had made one rule for the quality of limbs, the faces of men would resemble each other to such a degree that it would not be possible to distinguish one from the other; but she has varied the five features of the face in such a way that, although she has made an almost universal rule with regard to their size, she has not done so with regard to their quality, so that each one can be clearly distinguished from the other.

61.

It is an easy matter for him who knows man to arrive at universal knowledge, since all terrestrial animals are similar in regard to their structure, that is to say, in regard to the muscles and bones, and they do not vary save in height and thickness; then there are the aquatic animals, and I will not persuade the painter that any rule can be made with regard to these because they are of infinite variety — so are the insects.

62.

The body of anything which is fed is continually dying and being reborn, since nourishment cannot enter save where the past nourishment is exhausted; and if it is exhausted, it no longer has life, and if you do not furnish it with nourishment equal to that which has been before, you will impair the health of the organism, and if you deprive it of this nourishment, life will be altogether destroyed. But if you supply it with so much as can be consumed in a day, then as much life will be restored as was consumed, like the light of the candle which is furnished to it by the fuel provided by the moisture of the candle, and this light with most speedy succour restores beneath what is consumed above as it dies in dusky smoke; and this death is continuous, likewise the continuity of the smoke is equal to the continuity of the fuel; and in the same moment the light dies and is born again together with the movement of its fuel.

63.

Man and animals are in reality vehicles and conduits of food, tombs of animals, hostels of Death, coverings that consume, deriving life by the death of others.

Light

64.

Look on light and consider its beauty. Shut your eyes, and look again: that

which you see was not there before, and that which was, no longer is. Who is he who remakes it if the producer is continually dying?

65.

Anaxagoras: Everything proceeds from everything, and everything becomes everything, because that which exists in the elements is composed of those elements.

Nature

66.

Nature appears to have been the cruel stepmother rather than the mother of many animals, and in some cases not the stepmother, but the pitying mother.

67.

Why did nature not ordain that one animal should not live by the death of the other? Nature, being inconstant and taking pleasure in continually creating and making lives and forms, because she knows that her earthly materials are thereby augmented, is more willing and swift to create than time is to destroy; and so she has ordained that many animals shall feed on each other. And as even thus her desire is not satisfied, she frequently sends forth certain poisonous and pestilential vapours upon the increasing multitude and congregation of animals, and especially upon men who increase to a great extent, because other animals do not feed on them; and since there is no cause, there would follow no effect. This earth, therefore, seeks to lose its [animal] life, desiring only continual reproduction, and as, by the logical demonstration you adduce, effects often resemble their causes, animals are the image of the life of the world.

Life's Philosophy

68.

Now you see that the hope and the desire of returning home to one's former state is like the desire of the moth for the light, and the man who, with constant yearning and joyful expectancy, awaits the new spring and the new summer, and every new month and the new year, and thinks that what he longs for is ever too late in coming, and does not perceive that he is longing for his own destruction. But this desire is the quintessence, the spirit, of the elements, which, finding itself captive in the soul of the human body, desires always to return to its giver. And I would have you know that this same desire is the quintessence which is inseparable from nature, and that man is the model of the world. And such is the supreme folly of man that he labours so as to labour no more, and life flies from him while he forever hopes to enjoy the goods which he has acquired at the price of great labour.

The Senses and the Soul

69.

The soul seems to dwell in the intellect, and the intellect appears to dwell in that part where all the senses meet which is called the brain, and the brain does not pervade the whole body, as many have thought; on the contrary, it dwells entirely in one part, because if it were all in all and the same in every part, it would not have been necessary for the instruments of the senses to combine among themselves in one single spot; but rather, it would have been sufficient for the eye to fulfil the function of its sensation on the surface without transmitting, by means of the optic nerves, the likeness of its vision to the brain, so that the soul, for the reason given above, might perceive it in the surface of the eye. Likewise, with regard to the sense of hearing, it would have been sufficient if the voice had sounded only in the porous cavity of the indurated bone which lies within the ear, without making any further transit from this bone to the brain, which is its destination and where it discourses with common judgement. The sense of smell, too, is likewise compelled by necessity to proceed to the intellect; the sense of touch passes through the nerves and is conveyed to the brain, and these nerves diverge with infinite ramification in the skin, which encloses the limbs of the body and the entrails. The nerves convey volition and sensation to the muscles, and these nerves and the tendons which lie between the muscles and the sinews give movement to them; the muscles and sinews obey, and this obedience takes effect by the decrease of their thickness,

for in swelling their length is reduced, and the tendons which are interwoven among the particles of the limbs shrink, and as they extend to the tips of the fingers they transmit to the brain the cause of the sense of touch which they feel. The tendons with their muscles obey the nerves as soldiers obey their officers, and the nerves obey the brain as the officers obey their captain; thus the joint of the bones obeys the tendon, and the tendons obey the muscles, and the muscles obey the nerves, and the nerves obey the brain, and the brain is the dwelling of the soul, and the memory is its ammunition and the perception is its refundary.

Of Sensation

70.

The brain is that which perceives what is transmitted to it by the other senses. The brain moves by means of that which is transmitted to it by the five senses. Motion is transmitted to the senses by objects, and these objects, transmitting their images to the five senses, are transferred by them to the perception, and by the perception to the brain; and there they are comprehended and committed to the memory, in which, according to their intensity, they are more or less firmly retained.

The thinkers of ancient times concluded that the part of man which constitutes his intellect is caused by an instrument to which the other five senses refer everything by means of the perception, and this instrument they have named the “common sense” or brain, and they say that this sense is situated in the centre of the head. And they have given it this name “common sense” solely because it is the common judge of the five other senses, that is to say, sight, hearing, touch, taste and smell. The “common sense” is stirred by means of the perception which is placed between it and the senses. The perception is stirred by means of the images of things conveyed to it by the external instruments to the senses, and these are placed in the centre between the external things and the perception, and the senses likewise are stirred by objects. Surrounding objects transmit their images to the senses, and the senses transfer them to the perception, and the perception transfers them to the “common sense” (brain), and by it they are stamped upon the memory, and are there retained in a greater or lesser degree according to the importance and intensity of the impression. The sense which is most closely connected with the perception is the most rapid in action, and this sense is the eye, the highest and chief of the others; of this sense alone we will treat, and we will leave the others in order not to unduly lengthen our matter.

Automatic Movements

71.

Nature has ordained for man the ministering muscles which exercise the sinews, and by means of which the limbs can be moved according to the will and desire of the brain, like to officers distributed by a ruler over many provinces and towns, who represent their ruler in these places, and obey his will. And this officer, who will in a single instance have most faithfully obeyed the orders he received from his master by word of mouth, will afterwards, in a similar way, of his own accord fulfil the wishes of his master.

An example of this can be frequently seen in the fingers, which learn to perform on an instrument the things which the intellect commands, and the lesson once learnt they will perform it without the aid of the intellect. And do not the muscles which cause the legs to move perform their duty without man being conscious of it?

72.

You will see palsied and shivering persons move, and their trembling limbs, such as their head and hands, quiver, without the permission of the soul, and the soul, though it expend all its might, cannot prevent these limbs from trembling. The same thing occurs in epilepsy or when limbs are partially truncated, as in the case of tails of lizards.

Intellect

73.

It happens that our intellect is that which prompts the hand to create the features of figures in divine aspects until it finds satisfaction; and since the intellect is one of the tones of our soul, by means of the soul it composes the form of the body where it dwells, according to its volition. And when it has to reproduce a human body, it takes pleasure in repeating the body which it

originally created; whence it follows that they who fall in love are prone to become enamoured of what resembles them.

Of the Senses

74.

There are the four powers: memory, intellect, sensuality and lust. The first two are intellectual, the others sensual. Of the five senses, sight, hearing, smell are with difficulty prevented; touch and taste not at all. Taste follows smell in the case of dogs and other greedy animals.

75.

Why does the eye perceive things more clearly in dreams than with the imagination when one is awake?

Time

76.

Although time is included among continuous quantities, being indivisible and immaterial it does not altogether fall into the scope of geometry, — by which it is divided into figures and bodies of infinite variety, which are seen to be continuous inasmuch as they are visible and material, — but it agrees only with its first principles, *i.e.* with the point and the line; the point in time may be compared to an instant, and the line to the length of a certain quantity of time. Just as the point is the beginning and end of a line, so is an instant the beginning and end of any given space of time; and just as a line is infinitely divisible, so can a given space of time be likewise divided, and as the divisions of the line are in proportion to each other, so likewise are the divisions of time.

77.

In twelve whole figures the cosmography of the miniature world will be shown to you in the same manner as Ptolemy in his cosmography. And so I will divide it afterwards into limbs as he divided the world into provinces; then I will explain the function of the parts in every direction, and put before your eyes a description of the whole figure and substance of man as regards his movements by means of his limbs. And thus if it please our great author I will demonstrate the nature of man and his habits in the way I describe his form.

On the Human Body

78.

And thou, O man, who wilt gaze in this work of mine on the marvellous works of nature, if thou thinkest it would be an act of wickedness to destroy it, think how much more wicked it is to take the life of a man; and if this his structure appears to thee a miraculous work of art, remember that it is nothing in comparison with the soul which inhabits this structure; for verily, whatever it may be, it is divine. Let it, then, dwell in His work and at His good will, and let not thy rage or malice destroy so great a thing as life, for he who does not value it does not deserve it.

The Experimental Method

79.

By these rules thou wilt be able to distinguish falsehood from truth by means of which knowledge men aim at possible things with greater moderation; and do not veil thyself in ignorance, for the result of this would be that thou wouldst be ineffectual and fall into melancholy and despair.

Of Navigation below the Waters

80.

How by the aid of a machine many may remain for some time under water. And how and why I do not describe my method of remaining under water and of

living long without food; and I do not publish nor divulge these things by reason of the evil nature of man, who would use them for assassinations at the bottom of the sea and to destroy and sink ships, together with the men on board of them; and notwithstanding I will teach other things which are not dangerous....

Of Physiognomy

81.

I will not dwell on false physiognomy and chiromancy because there is no truth in them, and this is manifest because chimeras of this kind have no scientific foundation. It is true that the lineaments of the face partly reveal the character of men, their vices and temperaments; but in the face: (a) the features which separate the cheeks from the lips, and the nostrils and cavities of the eyes, are strongly marked if they belong to cheerful and good-humoured men, and if they are slightly marked it denotes that the men to whom they belong are given to meditation, (b) Those whose features stand out in great relief and depth are brutal and bad-tempered, and reason little, (c) Those who have strongly marked lines between the eyebrows are bad-tempered, (d) Those who have strongly marked lines on the forehead are men full of concealed or unconcealed bewailing.

And we can reason thus about many features. But the hand? You will find that whole armies perished in the same hour by the sword in which no two men had similar marks in their hands, and the same argument applies to a shipwreck.

Of Pain

82.

Nature has placed in the front part of man, as he moves, all those parts which when struck cause him to feel pain; and this is felt in the joints of the legs, the forehead and the nose, and has been so devised for the preservation of man, because if such pain were not felt in these limbs they would be destroyed by the many blows they receive.

Why Plants do not feel Pain

83.

While nature has ordained that animals should feel pain in order that the instruments which might be liable to be maimed or marred by motion may be preserved, plants do not come into collision with the objects which are before them; whence pain is not a necessity for them, and therefore when they are broken they do not feel pain, as animals do.

84.

Lust is the cause of generation.

Appetite is the support of life.

Fear or timidity is the prolongation of life.

Pain is the preserver of the instrument (of the human frame).

Fear

85.

Just as courage is the danger of life, so is fear its safeguard.

Body and Soul

86.

Let him who wishes to see how the soul inhabits its body observe what use the body makes of its daily habitation; that is to say, if the soul is full of confusion and disorder the body will be kept in disorder and confusion by the soul.

87.

The soul can never be corrupted with the corruption of the body, but it is like

the wind which causes the sound of the organ, and which ceases to produce a good effect when a pipe is spoilt.

Memory

88.

Every loss which we incur leaves behind it vexation in the memory, save the greatest loss of all, that is, death, which annihilates the memory, together with life.

Spirit

89.

Our body is subject to Heaven, and Heaven is subject to the Spirit.

Sense and Reason

90.

The senses are earthly; reason lies outside them when in contemplation.

91.

Where most feeling exists, there amongst martyrs is the greatest martyr.

92.

That which can be lost cannot be deemed riches. Virtue is our true wealth and the true reward of its possessor; it cannot be lost, it never deserts us until life leaves us. Hold property and external riches with fear; they often leave their

possessor scorned and mocked at for having lost them.

Flight of Time

93.

Men wrongly lament the flight of time, blaming it for being too swift; they do not perceive that its passage is sufficiently long, but a good memory, which nature has given to us, causes things long past to seem present.

Illusions

94.

Our intellect does not judge events which happened at various intervals of time in their true proportion, because many things which happened years ago appear recent and close to the present, and often recent things appear old and seem to belong to our past childhood. The eye does likewise with regard to distant objects which in the light of the sun appear to be close to the eye, and many objects which are close appear to be remote.

95.

Let us not lack ways and means of dividing and measuring these our wretched days, which we ought to take pleasure in spending and living not vainly and not without praise, nor without leaving any memory in the minds of men, so that this our miserable existence may not be spent in vain.

Virtuous Life

96.

The age which flies glides by in stealth and deceives others; and nothing is more swift than the years, and he who sows virtue reaps glory.

Sleep and Death

97.

O sleeper, what is sleep? Sleep is like unto death. Why dost thou not work in such wise that after death thou mayst have the semblance of perfect life, just as during life thou hast in thy sleep the semblance of the hapless dead?

98.

The water you touch in a river is the last of that which has gone, and the first of that which is coming: so it is with time present.

99.

A long life is a life well spent.

Life

100.

As a well spent day affords happy sleep, so does a life profitably employed afford a happy death.

Time the Destroyer

101.

O time, consumer of things! O envious age! Thou dost destroy all things, and consumest all things with the hard teeth of old age, little by little in a slow death. Helen, when she looked in her mirror and saw the withered wrinkles made in her

face by old age, wept, and wondered why she had twice been ravished. O time, devourer of things! O envious age, by which all is consumed!

On Fault-finders

102.

There exists among the foolish a certain sect of hypocrites who continually seek to deceive themselves and others, but others more than themselves, though in reality they deceive themselves more than others. And these are they who blame the painters who study on feast-days the things which relate to the true knowledge of the forms of the works of nature, and sedulously strive to acquire knowledge of these things to the best of their ability.

But such fault-finders pass over in silence the fact that this is the true manner of knowing the Artificer of such great and marvellous things, and that this is the true way in which to love so great an Inventor! For great love proceeds from the perfect knowledge of the thing loved; and if you do not know it you can love it but little or not at all; and if you love it for the gain which you anticipate obtaining from it and not for its supreme virtue, you are like the dog which wags its tail and shows signs of joy, leaping towards him who can give him a bone. But if you knew the virtue of a man you would love him more — if that virtue was in its place.

Prayer

103.

I obey Thee, Lord, first for the love which in reason I ought to bear Thee; secondly because Thou hast the power to shorten or prolong the lives of men.

104.

Thou, O God, dost sell us all good things at the price of labour.

105.

And many make a trade deceiving the foolish multitude, and if no one comes to unmask their deceptions, they punish it.

106.

Pharisees, — that is to say, holy friars.

107.

Nothing can be written by means of new researches.

Patience

108.

Patience serves against insults as clothes do against the cold; since if you multiply your clothes as the cold increases, the cold cannot hurt you. Similarly, let thy patience increase under great offences, and they will not be able to hurt your feelings.

Advice to a Speaker

109.

Words which do not satisfy the ear of the listener will always weary or annoy him; and you will often see signs of this in such listeners in their frequent yawns. Therefore, you who speak before men whose good opinion you seek, when you observe such signs of vexation, shorten your speech or vary your argument; and if you do otherwise, then instead of the favour you seek you will incur hate and hostility.

And if you would see what gives pleasure to a man speak to him on various

themes, and when you see him intent, without yawning, or contracting his brow, or performing other actions, then be certain that the matter of which you are speaking is such as affords him pleasure.

Advice

110.

Here is a thing which the more it is needed the more it is rejected: and this is advice, which is unwillingly heeded by those who most need it, that is to say, by the ignorant.

Here is a thing which the more you fear and avoid it the nearer you approach to it, and this is misery; the more you flee from it the more miserable and restless you will become. When the work comes up to the standard of the judgement, this is a bad sign for the judgement; and when the work excels the standard of the judgement, this is the worst sign, as occurs when a man marvels at having worked so well; and when the standard of the judgement exceeds that fulfilled by the work, this is a sign of perfection; and if the man is young and be thus disposed, he will without doubt grow into an excellent workman: he will only accomplish few works. But they will be of a quality which will compel men to contemplate their perfection with admiration.

Proverbs

111.

Nothing should be so greatly feared as empty fame.

This empty fame issues from vices.

A broken vase of clay can be remodelled, but this is no longer possible when it has been baked.

The vow is born when hope dies.

The beautiful is not always the good. And the fine talkers labour under this error without any reason.

He who wishes to grow rich in a day will be hanged in a year.

The memory of benefits is a frail defence against ingratitude.

Reprove your friend in secret and praise him in public.

He who fears dangers will not perish by them.

The evil which does me no harm is like the good which in no wise avails me.
He who offends others is not himself secure.
Be not false about the past.
Folly is the shield of lies, just as unreadiness is the defence of poverty.
Where there is liberty, there is no rule.

Here is a thing which the more it is heeded the more it is spurned, — advice.
It is ill to praise, and worse to blame, the thing which you do not understand.
On Mount Etna the words freeze in your mouth and you make ice of them.
Threats are the only weapons of the threatened man.
Ask advice of him who governs himself well.
Justice needs power, intelligence and will, and is like the Queen Bee.
Not to punish evil is equivalent to authorizing it.
He who takes the snake by the tail will be bitten by it.
The pit will fall in upon him who digs it.
He who does not restrain voluptuousness is in the category of the beasts.
You can have no dominion greater or less than that over yourself.
He who thinks little errs much.
It is easier to contend at the first than at the last.
No counsel is more sincere than that given on ships which are in danger.
Let him who acts on the advice of the young expect loss.
You grow in reputation like bread in the hands of a child.

Cannot beauty and utility be combined — as appears in citadels and men?
He who is without fear often incurs great losses, and is often full of regret.
If you governed your body according to virtue you would not live in this world.

Where good fortune enters, envy lays siege to her and attacks her, and when she departs sorrow and regret remain behind.

When beauty exists side by side with ugliness, the one seems more powerful, owing to the presence of the other.

He who walks straight rarely falls.

O miserable race of man! of how many things you make yourself the slave for the sake of money!

The worst evil which can befall the artist is that his work should appear good in his own eyes.

To speak well of a bad man is the same as speaking ill of a good man.

Truth ordains that lying tongues shall be punished by the lie.

He who does not value life does not deserve it.

The beautiful works of mortals pass and do not endure.
Labour flies with fame almost hidden in its arm.
The gold in ingots is refined in the fire.

The shuttle says: I will continue to move until the cloth is woven.
Everything that is crooked is straightened.
Great ruin proceeds from a slight cause.
Fine gold is recognized when it is tested.
The image will correspond to the die.
The wall will fall on him who scrapes it.
Ivy lives long.

To the traitor, death is life, because if he makes use of others he is no longer believed.

When fortune comes seize her in front firmly, because behind she is bald.
Constancy means, not he who begins, but he who perseveres.
I do not yield to obstacles.
Every obstacle is overcome by resolve.
He who is chained to a star does not change.

Truth

112.

Fire destroys falsehood, — that is to say, sophistry, — and rehabilitates truth, scattering the darkness.

Fire must be represented as the consumer of all sophistry and the revealer of truth, because it is light and scatters darkness which conceals all essences.

Fire destroys all sophistry, — that is to say, deceit, — and preserves truth alone, which is gold. Truth cannot be concealed in the end, dissimulation is of no avail. Dissimulation is frustrated before so great a judge. Falsehood puts on a mask.

There is nothing hidden under the sun. Fire must represent truth because it destroys all sophistry and lies, and the mask is for sophistry and lies, which conceal truth.

113.

Rather privation of limbs than weariness of doing good. The power of using my limbs shall fail me before the power of being useful. Rather death than weariness. I cannot be satiated with serving. I do not weary of giving help. No amount of work is sufficient to weary me. This is a carnival motto: "Sine lassitudine." Hands in which ducats and precious stones abound like snow never grow weary of serving, but such a service is for its utility only and not for our profit. Nature has formed me thus.

Ingratitude

114.

This shall be placed in the hand of ingratitude: The wood nourishes the fire that consumes it. When the sun, the scatterer of darkness, shines, you put out the light which for you in particular, and for your need and convenience, expelled the darkness.

Physiological Inferiority of Man

115.

I have found that in the composition of the human body as compared with the bodies of animals the senses are less subtle and coarser; it is thus composed of less ingenious machinery and of cells less capable of receiving the power of senses. I have seen that in the lion the sense of smell is connected with the substance of the brain and descends through the nostrils which form an ample receptacle for it; and it enters into a great number of cartilaginous cells which are provided with many passages in order to receive the brain. A large part of the head of the lion is given up to the sockets of the eyes, and the optic nerves are in immediate contact with the brain; the contrary occurs in man, because the sockets of the eyes occupy a small portion of the head, and the optic nerves are subtle and long and weak, and owing to the weakness of their action we see little by day and less at night; and the animals above mentioned see better at night than in the daytime; and the proof of this is that they seek their prey at night and sleep during the daytime, as do also the nocturnal birds.

Man's Ethical Inferiority

116.

Thou hast described him king of animals, but I would rather say, king of beasts, thou being the greatest — for hast thou not slain them in order that they may give thee their children to glut thy greed with which thou hast striven to make a sepulchre for all animals? And I would say still more if I might speak the whole truth. But let us confine ourselves to human matters, relating one supreme infamy, which is not to be found among the animals of the earth; because among these you will not find animals who eat their young, except when they are utterly foolish (and there are few indeed of such among them), and this occurs only among the beasts of prey, such as the lions, and leopards, panthers, lynxes, cats and the like, which sometimes feed on their young; but thou, besides thy children, dost devour thy father, thy mother, thy brother and thy friends; and not satisfied with this, thou goest forth to hunt on the islands of others, seizing other men and these half naked ... thou fattenest and chasest them down thy own throat. Now does not nature produce enough vegetables for thee to satisfy thyself? And if thou art not content with vegetables, canst thou not by a mixture of them make infinite compounds as Platina wrote, and other writers on food?

Man in the Animal World

117.

The description of man, including that of such creatures belonging almost to the same species, such as apes, monkeys and the like, of which there are many.

118.

The way of walking in man is similar in all cases to the universal way of walking in four-footed animals, because, just as they move their feet crosswise, like a trotting horse, so man moves his four limbs crosswise, that is to say, in walking he puts forward his right foot simultaneously with his left arm, and so on vice versa.

119.

Write a special treatise to describe the movements of four-footed animals, among which is man, who in his childhood also walks on four feet.

Fragment of a Letter 120.

There is one who having promised me much less than his due, and being disappointed of his presumptuous desire, has tried to deprive me of all my friends; and finding them wise and not pliable to his will, he has threatened me that he would bring accusations against me and alienate my benefactors from me: hence I have informed Your Lordship of this, so that this man, who wishes to sow the usual scandals, may not find a soil fit for sowing the thoughts and deeds of his evil nature; and that when he tries to make Your Lordship the tool of his infamous and malicious nature he may be disappointed of his desire.

Giacomo of Pupil of Leonardo

121.

On the 23d of April, 1490, I began this book; and started again on the horse. Giacomo came to live with me on Saint Mary Magdalen's day in 1490; he was ten years old. He was a thief, a liar, obstinate, and a glutton. On the second day I had two shirts made for him, a pair of socks and a jerkin, and when I placed the money aside to pay for these things, he stole it out of the purse and I could never force him to confess the fact, though I was quite certain of it — 4 lire. On the following day I went to sup with Giacomo Andrea, and this same Giacomo supped for two and did mischief for four, since he broke three bottles, spilled the wine, and after this came to sup where I... Item: on the 7th of September he stole a silver point, worth twelve soldi, from Marco, who was living with me, and took it from his studio; and when Marco had looked for it for some time he found it hidden in Giacomo's box — lire 1, soldi 2. Item: on the 26th of the following January, being in the house of Messer Galeazzo di San Severino, in order to arrange the festivity of his joust, and certain henchmen having undressed to try on the costumes of rustics who were to take part in the aforesaid festivity, Giacomo took the purse of one of them, which was on the bed with other clothes, and stole the money he found in it — 2 lire, 4 soldi. Item: Maestro Agostino of Padua gave me while I was in the same house a Turkish hide to have

a pair of shoes made of it, and Giacomo stole this from me within a month and sold it to a cobbler for 20 soldi, with which money by his own confession he bought sweets of aniseed. Item: again, on the 2d of April, Giovanni Antonio left a silver point on one of his drawings, and Giacomo stole it; it was worth 24 soldi, — 1 lire, 4 soldi. The first year a cloak, 2 lire; six shirts, 4 lire; three doublets, 6 lire: four pairs of socks, 7 lire, 8 soldi.

122.

And in this case I know that I shall make not a few enemies, since no one will believe what I say of him; because there are but few whom his vices have disgusted, indeed they only disgusted those men whose natures are contrary to such vices; and many hate their fathers and break off friendship with those who reprove their vices, and they will have no examples brought up against them, nor tolerate any advice. And if you meet with any one who is good and virtuous drive him not away from you, do him honour, so that he may not have to flee from you and hide in hermitages, or caverns and other solitary spots, in order to escape from your treachery; and if there be such an one do him honour, because these are your gods upon earth, they deserve statues from you and images ... but remember that you are not to eat their images, as is practised still in some parts of India, where, when images have performed some miracle, the priests cut them in pieces (since they are of wood) and distribute them among the people of the country, not without payment, and each one grates his portion very fine and puts it upon the first food he eats; and thus they believe that they have eaten their saint by faith, who will preserve them from all perils. What is thy opinion, O man, of thy own species? Art thou so wise as thou believest to be? Are these things to be done by men?

Pleasure and Pain

123.

This represents pleasure together with pain because one is never separated from the other; they are depicted back to back because they are opposed to each other; they are represented in one body because they have the same basis, because the source of pleasure is labour mingled with pain, and the pain issues

from the various evil pleasures. And it is therefore represented with a reed in its right hand which is ineffectual and devoid of strength, and the wounds inflicted by it are poisonous. In Tuscany such reeds are placed to support beds, to signify that this is the place of idle dreams, that here a great part of life is consumed, here much useful time is wasted, that is, the morning hours when the mind is sober and rested and the body disposed to start on fresh labours; there, again, many vain pleasures are enjoyed by the mind, which pictures to itself impossible things, and by the body, which indulges in those pleasures that are so often the cause of the failing of life; and for this reason the reed is used as their support.

Brain and Soul

124.

The spirit returns to the brain whence it had departed, with a loud voice and uttering these words: O blissful and fortunate spirit, whence comest thou? I have known this man well, against my will. He is a receptacle of villainy, he is a very heap of the highest ingratitude combined with all the other vices. But why should I tire myself with vain words? Nothing is to be found in him save the accumulation of all sins, and if there is to be found among them any that possess good, they will not be treated differently than I have been by other men; in short I have come to the conclusion that they are bad if they are enemies, and worse if they are friends.

Of the Eye

125.

The eye, which reflects the beauty of the universe to those who see, is so excellent a thing that he who consents to its loss deprives himself of the spectacle of the works of nature; and it is owing to this spectacle, effected by means of the eye, which enables the soul to behold the various objects of nature, that the soul is content to remain in the prison of the body; but he who loses his eyesight leaves the soul in a dark prison, where all hope of once more beholding the sun, the light of the whole world, is lost.... And how many are they who feel great hatred for the darkness of night, although it is brief. Oh! what would they do were they constrained to abide in this darkness during the whole of their life?

Certainly there is no one who would not rather lose his hearing or his sense of smell than his eyesight, and the loss of hearing includes the loss of all sciences which find expression in words; and this loss a man would incur solely so as not to be deprived of the sight of the beauty of the world which consists in the surfaces of bodies artificial as well as natural, which are reflected in the human eye.

The Eye in Animal Life

126.

Animals suffer greater loss in losing their sight than their hearing for many reasons: firstly, because it is by means of their sight that they find the food which is their nourishment, and is necessary for all animals; secondly, because by means of sight the beauty of created things is apprehended, especially those which lead to love, while he who is born blind cannot apprehend such beauty by hearing, because he has never received any knowledge as to what is beauty of any kind. There remains hearing, by which I mean only the human voice and speech; they contain the names of all things whatsoever. It is possible to live happily without the knowledge of these words, as is seen in those who are born deaf, that is to say, the dumb, who take delight in drawing.

Ascension of Monte Rosa

127.

I say that the azure we see in the atmosphere is not its true colour, but is caused by warm moisture evaporated in minute and insensible atoms which the solar rays strike, rendering them luminous against the darkness of the infinite night of the fiery region which lies beyond and includes them. And this may be seen, as I saw it, by him who ascends Mounboso (Monte Rosa), a peak of the Alps which separates France from Italy. The base of this mountain gives birth to the four large rivers which in four different directions water the whole of Europe; and no mountain has its base at so great a height as this. It rises to such a height that it almost lifts itself up above the clouds; snow seldom falls on it, but only hail in summer, when the clouds are at their greatest height, and this hail is preserved there so that were it not for the absorption of the rising and

falling clouds, which does not occur twice in an age, a great quantity of ice would be piled up there by the hail, which in the middle of July I found to be very considerable; and I saw above me the dark air, and the sun which struck the mountain shone far lighter than in the plains below, because a lesser quantity of atmosphere lay between the summit of the mountain and the sun.

Prophecies

128.

Men will communicate with each other from the most distant countries, and reply.

Many will abandon their own habitations and take with them their own goods, and go and inhabit other countries.

Men will pursue the thing which they most greatly fear; that is to say, they will be miserable in order to avoid falling into misery.

Men standing in separate hemispheres will converse with each other, embrace each other, and understand each other's language.

129.

We should not desire the impossible.

II. THOUGHTS ON ART

The painter's work will be of little merit if he takes the painting of others as his standard, but if he studies from nature he will produce good fruits; as is seen in the case of the painters of the age after the Romans, who continued to imitate one another and whose art consequently declined from age to age. After these came Giotto the Florentine, who was born in the lonely mountains, inhabited only by goats and similar animals; and he, being drawn to his art by nature, began to draw on the rocks the doings of the goats of which he was the keeper; and thus he likewise began to draw all the animals which he met with in the country: so that after long study he surpassed not only all the masters of his age, but all those of many past centuries. After him art relapsed once more, because all artists imitated the painted pictures, and thus from century to century it went on declining, until Tomaso the Florentine, called Masaccio, proved by his perfect work that they who set up for themselves a standard other than nature, the mistress of all masters, labour in vain.

Thus I wish to say, in regard to these mathematical matters, that they who merely study the masters and not the works of nature are the grandchildren, and not the children, of nature, the mistress of good masters. I abhor the supreme folly of those who blame the disciples of nature in defiance of those masters who were themselves her pupils.

Its Origin

2.

The first picture was a single line, drawn round the shadow of a man cast by the sun on the wall.

3.

Vastness of the field of painting: All that is visible is included in the science of painting.

Defence of Painting

4.

With due lamentation Painting complains that it has been expelled from the liberal arts, because it is the true daughter of nature and is practised by means of the most worthy of the senses. Whence wrongly, O writers, you have excluded painting from the liberal arts, since it not only includes in its range the works of nature, but also infinite things which nature never created.

5.

Because writers have had no knowledge of the science of painting, they have not been able to describe its gradations and parts, and since painting itself does not reveal itself nor its artistic work in words, it has remained, owing to ignorance, behind the sciences mentioned above, but it has thereby lost nothing of its divinity. And truly it is not without reason that men have failed to honour it, because it does honour to itself without the aid of the speech of others, just as do the excellent works of nature. And if the painters have not described the art of painting, and reduced it to a science, the fault must not be imputed to painting and it is no less noble on that account, since few painters profess a knowledge of letters, as their life would not be long enough for them to acquire such knowledge. Therefore we ask, Is the virtue of herbs, stones and plants non-existent because men have been ignorant of it? Certainly not; but we will say that these herbs remained noble in themselves without the aid of human tongues or letters.

Painting

6.

A science is more useful in proportion as its fruits are more widely understood, and thus, on the other hand, it is less useful in proportion as it is less widely understood. The fruits of painting can be apprehended by all the

populations of the universe because its results are subject to the power of sight, and it does not pass by the ear to the brain, but by the same channel by which sight passes. Therefore it needs no interpreters of diverse tongues, as letters do, and it has instantly satisfied the human race in the same manner as the works of nature have done. And not only the human race, but other animals; as was shown in a picture representing the father of a family to whom little children still in the cradle gave caresses, as did the dog and the cat in the same house; and it was a wonderful thing to see such a sight.

7.

The arts which admit of exact reproduction are such that the disciple is on the same level as the creator, and so it is with their fruits. These are useful to the imitator, but are not of such high excellence as those which cannot be transmitted as an inheritance like other substances. Among these painting is the first. Painting cannot be taught to him on whom nature has not conferred the gift of receiving such knowledge, as mathematics can be taught, of which the disciple receives as much as the master gives him; it cannot be copied, as letters can be, in which the copy equals the original; it cannot be stamped, in the same way as sculpture, in which the impression is in proportion to the source as regards the quality of the work; it does not generate countless children, as do printed books. It alone remains noble, it alone confers honour on its author and remains precious and unique, and does not beget children equal to itself. And it is more excellent by reason of this quality than by reason of those which are everywhere proclaimed. Now do we not see the great monarchs of the East going about veiled and covered up from the fear of diminishing their glory by the manifestation and the divulgation of their presence? and do we not see that the pictures which represent the divine deity are kept covered up with inestimable veils? their unveiling is preceded by great sacred solemnities with various chants and diverse music, and when they are unveiled, the vast multitude of people who are there flocked together, immediately prostrate themselves and worship and invoke those whom such pictures represent that they may regain their lost holiness and win eternal salvation, just as if the deity were present in the flesh. This does not occur in any other art or work of man. And if you say that is owing to the nature of the subject depicted rather than to the genius of the painter, the answer is that the mind of man could satisfy itself equally well in this case, were the man to remain in bed and not make pilgrimages to places which are perilous

and hard of access, as we so often see is the case. But if such pilgrimages continually exist, what is then their unnecessary cause? You will certainly admit that it is an image of this kind, and all the writings in the world could not succeed in representing the semblance and the power of such a deity. Therefore it appears that this deity takes pleasure in the pictures and is pleased that it should be loved and revered, and takes a greater delight in being worshipped in that rather than in any other semblance of itself, and by reason of this it bestows grace and gifts of salvation according to the belief of those who meet together in such a place.

Painting excels all the Works of Man

8.

The eye, which is called the window of the soul, is the principal means by which the brain can most abundantly and splendidly contemplate the infinite works of nature; and the ear is the next in order, which is ennobled by hearing the recital of the things seen by the eye. If you, historians and poets, or mathematicians, had not seen things with the eyes, you could not report of them in writing. If thou, O poet, dost tell a story with thy painting pen, the painter will more easily give satisfaction in telling it with his brush and in a manner less tedious and more easily understood. And if thou callest painting mute poetry, the painter can call poetry blind painting. Now consider which is the greater loss, to be blind or dumb? Though the poet is as free as the painter in his creations and compositions, they are not so satisfactory to men as paintings, because if poetry is able to describe forms, actions and places in words, the painter deals with the very semblance of forms in order to represent them. Now consider which is nearer to man, the name of man or the image of man? The name of man varies in diverse countries, but death alone changes his form. If thou wast to say that painting is more lasting, I answer that the works of a coppersmith, which time preserves longer than thine or ours, are more eternal still. Nevertheless there is but little invention in it, and painting on copper with colours of enamel is far more lasting.

We by our art can be called the grandsons of God. If poetry deals with moral philosophy, painting deals with natural philosophy; if poetry describes the action of the contemplative mind, painting represents the effect in motion of the action of the mind; if poetry terrifies people with the pictures of Hell, painting does the same by depicting the same things in action. If a poet challenges the painter to

represent beauty, fierceness, or an evil, an ugly or a monstrous thing, whatever variety of forms he may produce in his way, the painter will cause greater satisfaction. Are there not pictures to be seen so like reality that they deceive men and animals?

Painting creates Reality

9.

The imagination is to the effect as the shadow to the opaque body which causes the shadow, and the proportion is the same between poetry and painting. Because poetry produces its results in the imagination of the reader, and painting produces them in a concrete reality outside the eye, so that the eye receives its images just as if they were the works of nature; and poetry produces its results without images, and they do not pass to the brain through the channel of the visual faculty, as in painting.

10.

Painting represents to the brain the works of nature with greater truth and accuracy than speech or writing, but letters represent words with greater truth, which painting does not do. But we say that the science which represents the works of nature is more wonderful than that which represents the works of the artificer, that is to say, the works of man, which consist of words — such as poetry and the like — which issue from the tongue of man.

The Painter goes to Nature

11.

Painting ministers to a nobler sense than poetry, depicts the forms of the works of nature with greater truth than poetry; and the works of nature are nobler than the words which are the works of man, because there is the same proportion between the works of man and those of nature as there is between man and God. Therefore it is a more worthy thing to imitate the works of nature, which are the

true images embodied in reality, than to imitate the actions and the words of men.

And if thou, O poet, wishest to describe the works of nature by thine unaided art, and dost represent various places and the forms of diverse objects, the painter surpasses thee by an infinite degree of power; but if thou wishest to have recourse to the aid of other sciences, apart from poetry, they are not thy own; for instance, astrology, rhetoric, theology, philosophy, geometry, arithmetic and the like. Thou art not then a poet any longer. Thou transformest thyself, and art no longer that of which we are speaking. Now seest thou not that if thou wishest to go to nature, thou reachest her by the means of science, deduced by others from the effects of nature? And the painter, through himself alone, without the aid of aught appertaining to the various sciences, or by any other means, achieves directly the imitation of the things of nature. By painting, lovers are attracted to the images of the beloved to converse with the depicted semblance. By painting whole populations are led with fervent vows to seek the image of the deities, and not to see the books of poets which represent the same deities in speech; by painting animals are deceived. I once saw a picture which deceived a dog by the image of its master, which the dog greeted with great joy; and likewise I have seen dogs bark at and try to bite painted dogs; and a monkey make a number of antics in front of a painted monkey. I have seen swallows fly and alight on painted iron-works which jut out of the windows of buildings.

Superiority of Painting to Philosophy

12.

Painting includes in its range the surface, colour and shape of anything created by nature; and philosophy penetrates into the same bodies and takes note of their essential virtue, but it is not satisfied with that truth, as is the painter, who seizes hold of the primary truth of such bodies because the eye is less prone to deception.

Painting & Poetry

13.

Poetry surpasses painting in the representation of words, and in the representation of actions painting excels poetry; and painting is to poetry as actions are to words, because actions depend on the eye and words on the ear; and thus the senses are in the same proportion one to another as the objects on which they depend; and on this account I consider painting to be superior to poetry. But since those who practised painting were for long ignorant as to how to explain its theory, it lacked advocates for a considerable time; because it does not speak itself, but reveals itself and ends in action, and poetry ends in words, which in its vainglory it employs for self-praise.

Painting is Mute Poetry

14.

What poet will place before thee in words, O lover, the true semblance of thy idea with such truth as will the painter? Who is he who will show thee rivers, woods, valleys and plains, which will recall to thee the pleasures of the past, with greater truth than the painter? And if thou sayest that painting is mute poetry in itself, unless there be some one to speak for it and tell what it represents — seest thou not, then, that thy book is on a lower plane? Because even if it have a man to speak for it, nothing of the subject which is related can be seen, as it is seen when a picture is explained. And the pictures, if the action represented and the mental attributes of the figures are in the true proportion one to another, will be understood in the same way as if they spoke.

15.

Painting is mute poetry, and poetry is blind painting. Therefore these two forms of poetry, or rather these two forms of painting, have exchanged the senses through which they should reach the intellect. Because if they are both of them painting, they must reach the brain by the noblest sense, namely, the eye; if they are both of them poetry, they must reach the brain by the less noble sense, that is, the hearing. Therefore we will appoint the man born deaf to be judge of painting, and the man born blind to be judge of poetry; and if in the painting the movements are appropriate to the mental attributes of the figures which are engaged in any kind of action, there is no doubt that the deaf man will

understand the action and intentions of the figures, but the blind man will never understand what the poet shows, and what constitutes the glory of the poetry; since one of the noblest functions of its art is to describe the deeds and the subjects of stories, and adorned and delectable places with transparent waters in which the green recesses of their course can be seen as the waves disport themselves over meadows and fine pebbles, and the plants which are mingled with them, and the gliding fishes, and similar descriptions, which might just as well be made to a stone as to a man born blind, since he has never seen that which composes the beauty of the world, that is, light, darkness, colour, body, shape, place, distance, propinquity, motion and rest, which are the ten ornaments of nature.

But the deaf man, lacking the less noble sense, although he has at the same time lost the gift of speech, since never having heard words spoken he never has been able to learn any language, will nevertheless perfectly understand every attribute of the human body better than a man who can speak and hear; and likewise he will know the works of painters and what is represented in them, and the action which is appropriate to such figures.

Painting is Mute Poetry

16.

Painting is mute poetry, and poetry is blind painting, and both imitate nature to the best of their powers, and both can demonstrate moral principles, as Apelles did in his Calumny. And since painting ministers to the most noble of the senses, the eye, a harmonious proportion ensues from it, that is to say, that just as from the concord of many diverse voices at the same moment there ensues a well-proportioned harmony which will please the sense of hearing to such an extent that the listeners in dizzy admiration are like men half ravished of their senses, still greater will be the effect of the beautiful proportions of a celestial face in a picture from whose proportions a harmonious concord will ensue, which delights the eye in one moment, just as music delights the ear. And if this harmonious beauty is shown to one who is the lover of the woman from whom such great beauty has been copied, he will most certainly be struck dizzy with admiration and incomparable joy superior to that afforded by all the other senses.

But with regard to poetry, which in order to afford the representation of a perfect beauty is obliged to describe each separate part in detail, — a

representation which in painting produces the harmony described above, — no further charm is produced than would occur in music if each voice were to be heard separately at various intervals of time, whence no concord would ensue; just as if we wished to show a countenance bit by bit, always covering up the parts already shown, forgetfulness would prevent the production of any harmonious concord, since the eye could not apprehend the parts with its visual faculty at the same moment. The same thing occurs in the beauty of any object created by the poet, for as its parts are related separately, at separate times the memory receives no harmony from it.

The Impression of Painting

17.

Painting reveals itself immediately to thee with the semblance given it by its creator, and affords to the chief of the senses as great a delight as any object created by nature. And the poet in this case reveals the same objects to the brain by the channel of the hearing, the inferior sense, and affords the eye no more pleasure than it derives from anything which is related. Now consider what a difference there is between hearing the recital of a thing which in the course of time gives pleasure to the eye, and perceiving it with the same velocity with which we apprehend the works of nature.

And in addition to the fact that a long interval of time is necessary to read the works of the poets, it often occurs that they are not understood, and it is necessary to make diverse comments on them, and it is exceedingly rare that the commentators are agreed as to the meaning of the poet; and often the readers peruse but a small portion of their works, owing to lack of time. But the works of the painter are immediately understood by those who behold them.

18.

Painting manifests its essence to thee in an instant of time, — its essence by the visual faculty, the very means by which the perception apprehends natural objects, and in the same duration of time, — and in this space of time the sense-satisfying harmony of the proportion of the parts composing the whole is formed. And poetry apprehends the same things, but by a sense inferior to that of

the eyesight, which bears the images of the objects named to the perception with greater confusion and less speed. Not in such wise acts the eye (the true intermediary between the object and the perception), for it immediately communicates the true semblance and image of what is represented before it with the greatest accuracy; whence that proportion arises called harmony, which with sweet concord delights the sense in the same way as the harmony of diverse voices delights the ear; and this harmony is less worthy than that which delights the eye, because for every part of it that is born a part dies, and it dies as fast as it is born. This cannot occur in the case of the eye; because if thou presentest a beautiful living mortal to the eye, composed of a harmony of fair limbs, its beauty is not so transient nor so quickly destroyed as that of music; on the contrary it has permanent duration, and allows thee to behold and consider it; and it is not reborn as in the case of music which is played many times over, nor will it weary thee: on the contrary, thou becomest enamoured with it, and the result it produces is that all the senses, together with the eye, would wish to possess it, and it seems that they would wish to compete with the eye: it appears that the mouth desires it for itself, if the mouth can be considered as a sense; the ear takes pleasure in hearing its beauty; the sense of touch would like to penetrate into all its pores; the nose also would like to receive the air it exhales.

Time in a few years destroys this harmony, but this does not occur in the case of beauty depicted by the painter, because time preserves it for long; and the eye, as far as its function is concerned, receives as much pleasure from the depicted as from the living beauty; touch alone is lacking to the painted beauty, — touch, which is the elder brother of sight; which after it has attained its purpose does not prevent the reason from considering the divine beauty. And in this case the picture copied from the living beauty acts for the greater part as a substitute; and the description of the poet cannot accomplish this. — the poet who is now set up as a rival to the painter, but does not perceive that time sets a division between the words in which he describes the various parts of the beauty, and that forgetfulness intervenes and divides the proportions which he cannot name without great prolixity; he cannot compose the harmonious concord which is formed of divine proportions. And on this account beauty cannot be described in the same space of time in which a painted beauty can be seen, and it is a sin against nature to attempt to transmit by the ear that which should be transmitted by the eye.

What prompts thee, O man, to abandon thy habitations in the city, to leave thy parents and friends, and to seek rural spots in the mountains and valleys, if it be not the natural beauty of the world, which, if thou reflectest, thou dost enjoy solely by means of the sense of sight? And if the poet wishes to be called a

painter in this connection also, why didst thou not take the descriptions of places made by the poet and remain at home without exposing thyself to the heat of the sun? Oh! would not this have been more profitable and less fatiguing to thee, since this can be done in the cool without motion and danger of illness? But the soul could not enjoy the benefit of the eyes, the windows of its dwelling, and it could not note the character of joyous places; it could not see the shady valleys watered by the sportiveness of the winding rivers; it could not see the various flowers, which with their colours make a harmony for the eye, and all the other objects which the eye can apprehend. But if the painter in the cold and rigorous season of winter can evoke for thee the landscapes, variegated and otherwise, in which thou didst experience thy happiness; if near some fountain thou canst see thyself, a lover with thy beloved, in the flowery fields, under the soft shadow of the budding boughs, wilt thou not experience a greater pleasure than in hearing the same effect described by the poet?

Here the poet answers, admitting these arguments; but he maintains that he surpasses the painter, because he causes men to speak and reason in diverse fictions, in which he invents things which do not exist, and that he will incite men to take arms, and describe the heavens, the stars, nature, and the arts and everything.

To which we reply that none of these things of which he speaks is his true profession; but if he wishes to speak and make orations, it can be shown that he is surpassed by the orator in this province; and if he speaks of astrology, that he has stolen the subject of the astrologer; and in the case of philosophy, of the philosopher; and that in reality poetry has no true position and merits no more consideration than a shopkeeper who collects goods made by various workmen. As soon as the poet ceases to represent by means of words the phenomena of nature, he then ceases to act as a painter, because if the poet leaves such representation and describes the flowery and persuasive speech of him to whom he wishes to give speech, he then becomes an orator, and neither a poet nor a painter; and if he speaks of the heavens he becomes an astrologer, and a philosopher and a theologian if he discourses of nature or God; but if he returns to the description of any object he would rival the painter, if with words he could satisfy the eye as the painter does.

But the spirit of the science of painting deals with all works, human as well as divine, which are terminated by their surfaces, that is, the lines of the limits of bodies by means of which the sculptor is required to achieve perfection in his art. She with her fundamental rules, *i.e.* drawing, teaches the architect how to work so that his building may be pleasant to the eye; she teaches the makers of diverse vases, the goldsmiths, weavers, embroiderers; she has found the

characters with which diverse languages find expression; she has given symbols to the mathematicians; she has taught geometry its figures, and instructed the astrologers, the makers of machines and engineers.

Poet and Painter

19.

The poet says that his science consists of invention and rhythm, and this is the simple body of poetry, invention as regards the subject matter and rhythm as regards the verse, which he afterwards clothes with all the sciences. To which the painter rejoins that he is governed by the same necessities in the science of painting, that is to say, invention and measure (fancy as regards the subject matter which he must invent, and measure as regards the matters painted), so that they may be in proportion, but that he does not make use of three sciences; on the contrary it is rather the other sciences that make use of painting, as, for instance, astrology, which effects nothing without the aid of perspective, the principal link of painting, — that is, mathematical astronomy and not fallacious astrology (let those who by reason of the existence of fools make a profession of it, forgive me). The poet says he describes an object, that he represents another full of beautiful allegory; the painter says he is capable of doing the same, and in this respect he is also a poet. And if the poet says he can incite men to love, which is the most important fact among every kind of animal, the painter can do the same, all the more so because he presents the lover with the image of his beloved; and the lover often does with it what he would not do with the writer's delineation of the same charms, *i.e.* talk with it and kiss it; so great is the painter's influence on the minds of men that he incites them to love and become enamoured of a picture which does not represent any living woman.

And if the poet pleases the sense by means of the ear, the painter does so by the eye, which is the superior sense. I will enlarge no further on this theme save to say that if a good painter were to represent the fury of a battle, and if the poet were to describe one, and both representations were put before the public together, you will see before which of the two most of the spectators will stop, to which of the two they will pay most attention, which of the two will be the most praised and give the greater satisfaction. Without any doubt, the painting, being infinitely the most beautiful and useful, will please the most. Write the name of God in some spot, and set up His image opposite, and you will see which will be the most revered. While painting embraces in itself all the forms of nature,

you have nothing save words, which are not universal, like forms. If you have the effects of the representation, we have the representation of the effects. Take a poet who describes the charms of a woman to her lover, and a painter who represents her, and you will see whither nature leads the enamoured critic. Certainly the proof should rest on the verdict of experience. You have classed painting among the mechanical arts, but, truly, if painters were as apt at praising their own works in writing as you are, it would not lie under the stigma of so unhonoured an name. If you call it mechanical because it is by manual work and that the hand represents the conception of the imagination, you writers put down with the pen the conceptions of your mind. And if you say that it is mechanical because it is done for money, who is more guilty of this error — if error it can be called — than you? If you lecture in the schools, do you not go to whomsoever rewards you most? Do you perform any work without some pay? Although I do not say this to blame such opinions, because all labour expects its reward; and if a poet were to say: “I will devise with my fancy a work which shall be pregnant with meaning,” the painter can do the same, as Apelles did when he painted The Calumny.

King Matthias & the Poet

20.

On the birthday of King Matthias, a poet brought him a work made in praise of the royal birthday for the benefit of the world, and a painter presented him with a portrait of his lady-love. The king immediately shut the book of the poet and turned to the picture, and remained gazing on it with profound admiration. Then the poet, greatly slighted, said: “O king, read, read, and thou wilt hear something of far greater substance than a dumb picture!” Then the king, hearing himself blamed for contemplating a mute object, said: “O poet, be silent, thou knowest not what thou sayest; this picture gratifies a nobler sense than thy work, which is for the blind. Give me an object which I can see and touch and not only hear, and blame not my choice in having placed thy work beneath my elbow, while I hold the work of the painter with both my hands before my eyes, because my very hands have chosen to serve a worthier sense than that of hearing.

“And as for my self I consider that the same proportion exists between the art of the painter and that of the poet as that which exists between the two senses on which they respectively depend.

“Knowest thou not that our soul is composed of harmony, and harmony can only be begotten in the moments when the proportions of objects are simultaneously visible and audible? Seest thou not that in thine art there is no harmony created in a moment, and that, on the contrary, each part follows from the other in succession, and the second is not born before its predecessor dies. For this reason I consider thy creation to be considerably inferior to that of the painter, simply because no harmonious concord ensues from it. It does not satisfy the mind of the spectator or the listener, as the harmony of the perfect features which compose the divine beauty of this face which is before me; for the features united all together simultaneously afford me a pleasure which I consider to be unsurpassed by any other thing on the earth which is made by man.”

Value of the Visible Universe

21.

There is no one so foolish who if offered the choice between everlasting blindness and deafness would not immediately elect to lose both his hearing and sense of smell rather than to be blind. Since he who loves his sight is deprived of the beauty of the world and all created things, and the deaf man loves only the sound made by the percussion of the air, which is an insignificant thing in the world.

Thou sayest that science increases in nobility in proportion as the subjects with which it deals are more elevated, and, for this reason, a false rendering of the being of God is better than the portrayal of a less worthy object; and on this account we will say that painting, which deals alone with the works of God, is worth more than poetry, which deals solely with the lying imaginings of human devices.

Poet and Painter

22.

Thou sayest, O painter, that worship is paid to thy work, but impute not this power to thyself, but to the subject which such a picture represents. Here the painter makes answer: O thou poet, who sayest that thou also art an imitator,

why dost thou not represent with thy words objects of such a nature that thy writings which contain these words may be worshipped also? But nature has favoured the painter more than the poet, and it is fair that the works of the more greatly favoured one should be more honoured than those of the less favoured one. Therefore let us praise him who with words satisfies the hearing, and him who by painting affords perfect content to the eyes; but let the praise given to the worker in words be less, inasmuch as they are accidental and created by a less worthy author than the works of nature of which the painter is the imitator. And the existence of these works is confined within the forms of their surfaces.

23.

Since we have concluded that the utmost extent of the comprehension of poetry is for the blind, and that of painting for the deaf, we will say that the value of painting exceeds that of poetry in proportion as painting gratifies a nobler sense than poetry does, and this nobility has been proved to be equal to that of three other senses, because we elect to lose our sense of hearing, smell and touch rather than our eyesight. For he who loses his sight is deprived of the beauty of the universe, and is like to one who is confined during his lifetime in a tomb, in which he enjoys life and motion.

Now seest thou not that the eye comprehends the beauty of the whole world? It is the head of astrology; it creates cosmography; it gives counsel and correction to all the human arts; it impels men to seek diverse parts of the world; it is the principle of mathematics; its science is most certain; it has measured the height and the magnitude of the stars; it has discovered the elements and their abodes; it has been able to predict the events of the future, owing to the course of the stars; it has begotten architecture and perspective and divine painting. O most excellent above all the things created by God! What praise is there which can express thy nobility? What peoples, what tongues, are they who can perfectly describe thy true working? It is the window of the human body, through which the soul gazes and feasts on the beauty of the world; by reason of it the soul is content with its human prison, and without it this human prison is its torment; and by means of it human diligence has discovered fire by which the eye wins back what the darkness has stolen from it. It has adorned nature with agriculture and pleasant gardens. But what need is there for me to indulge in long and elevated discourse? What thing is there which acts not by reason of the eye? It impels men from the East to the West; it has discovered navigation; and

in this it excels nature, because the simple products of the earth are finite and the works which the eye makes over to the hands are infinite, as the painter shows in his portrayal of countless forms of animals, herbs, plants and places.

Music the Sister of Painting

24.

Music should be given no other name than the sister of painting, inasmuch as it is subject to the hearing, — a sense inferior to the eye, — and it produces harmony by the unison of its proportioned parts, which are brought into operation at the same moment and are constrained to come to life and die in one or more harmonic times; and time is, as it were, the circumference of the parts which constitute the harmony, in the same way as the outline constitutes the circumference of limbs whence human beauty emanates.

But painting excels and lords over music because it does not die as soon as it is born, as occurs with music, the less fortunate; on the contrary, it continues to exist and reveals itself to be what it is, a single surface. O marvellous science, thou givest lasting life to the perished beauty of mortals, which are thus made more enduring than the works of nature, for these undergo forever the changes of time, and time leads them to inevitable old age! And this science is to divine nature as its works are to the works of nature, and on this account it is worshipped.

Painting & Music

25.

The most worthy thing is that which satisfies the most worthy sense; therefore painting, which satisfies the sense of sight, is more worthy than music, which merely satisfies the hearing. The most worthy thing is that which endures longest; therefore music, which is continually dying as soon as it is born, is less worthy than painting, which lasts eternally with the colours of enamel. The most excellent thing is that which is the most universal and contains the greatest variety of things; therefore painting must be set above all other arts, because it contains all the forms which exist and also those which are not in nature, and it should be glorified and exalted more than music, which deals with the voice

only.

With it images are made to the gods; around it divine worship is conducted, of which music is a subservient ornament; by means of it pictures are given to lovers of their beloved; by it the beauties are preserved which time, and nature the mother, render fitful; by it we retain the images of famous men. And if thou wert to say that by committing music to writing you render it eternal, we do the same with letters.

Therefore, since thou hast included music among the liberal arts, thou must either exclude it, or include the art of letters. And if thou wast to say: Painting is used by base men, in the same way is music spoilt by him who knows it not. If thou sayest that sciences which are not mechanical are mental, I will answer that painting is mental. And just as music and geometry deal with the proportions of continuous quantities, and arithmetic deals with discontinuous quantities, painting deals with all quantities and the qualities of the proportions of shadows, lights and distances, in its perspective.

Painter and Musician

26.

The musician says that his art can be compared with that of the painter because by the art of the painter a body of many members is composed, and the spectator apprehends its grace in as many harmonious rhythms ... as there are times in which it lives and dies; and by these rhythms ... its grace plays with the soul, which dwells in the body of the spectator. But the painter replies that the body composed of human limbs does not afford the delectable harmonious rhythms in which beauty must live and die, but renders it permanent for many years, and is of such great excellence that it preserves the life of this harmony of concordant limbs which nature with all her force could not preserve.

How many pictures have preserved the semblance of divine beauty of which time or death had in a brief space destroyed the living example: and the work of the painter has become more honoured than that of nature, his master!

If thou, O musician, sayest that painting is mechanical because it is wrought by the work of the hands, music is wrought by the mouth, but not by the tasting faculties of the mouth; just and as the hand is employed indeed in the case of painting, but not for its faculties of touch. Words are less worthy than actions. But thou, writer of science, dost thou not copy with thy hand, and write what is in thy mind, as the painter does? And if thou wast to say that music is formed of

proportion, by proportion have I wrought painting, as thou shalt see.

Poet Painter and Musician

27.

There is the same difference between the representation of the embodied works of the painter and those of the poet as there is between complete and dismembered bodies, because the poet in describing the beauty or the ugliness of any body reveals it to you limb by limb and at diverse times, and the painter shows the whole at the same time. The poet cannot express in words the true likeness of the limbs which compose a whole, as can the painter, who places it before you with the truth of nature. And the same thing befalls the poet as the musician, who sings by himself a song composed for four singers; and he sings the treble first, then the tenor, then the alto and then the bass, whence there results no grace of harmonious concord such as harmonious rhythms produce. And the poet is like a beautiful countenance which reveals itself to you feature by feature, that by so doing you may never be satisfied by its beauty, which consists of the divine proportion of the limbs united one with another, and these compose of themselves and at one time the divine harmony of this union of limbs, and often deprives the gazer of his liberty. Music, again, by its harmonious rhythm, produces the sweet melodies formed by its various voices, and their harmonious division is lacking to the poet; and although poetry enters into the abode of the intellect by the channel of the hearing, as does music, the poet cannot describe the harmony of music, because it is not in his power to say various things in one and the same moment as can the harmonious concord of painting, which is composed of various members which exist simultaneously, and the beauty of these parts is apprehended at the same time, individually and collectively, — collectively with regard to the whole, individually with regard to the component parts of which the whole is formed; and for this reason the poet is, as far as the representation of bodily things is concerned, greatly inferior to the painter, and as far as invisible things are concerned he is far behind the musician. But if the poet borrows the aid of the other sciences, he can appear at the fair like the other merchants, bearers of divers goods made by many artificers; and the poet does this when he borrows the science of others, such as that of the orator, the philosopher, the astrologer, the cosmographer and the like; and these sciences are altogether alien to the poet. Therefore he is an agent who brings together diverse persons in order to strike a bargain; and if you wish to

know the true function of the poet, you will find that he is no other than an assembler of goods stolen from other sciences, with which he makes a deceptive mixture, or more honestly said, a fictitious mixture. And with regard to this fiction the poet is free to compete with the painter, since it constitutes the least part of the painting.

28.

The painter emulates and competes with nature.

Painting a second Creation

29.

He who blames painting blames nature, because the works of the painter represent the works of nature, and for this reason he who blames in this fashion lacks feeling.

The Painter Lord of All

30.

If the painter wishes to see beautiful things which will enchant him he is able to beget them; if he wishes to see monstrous things which terrify, or grotesque and laughable things, or truly piteous things, he can dispose of all these; if he wishes to evoke places and deserts, shady or dark retreats in the hot season, he represents them, and likewise warm places in the cold season. If he wishes valleys, if he wishes to descry a great plain from the high summits of the mountains, and if he wishes after this to see the horizon of the sea, he can do so; and from the low valleys he can gaze on the high mountains, or from the high mountains he can scan the low valleys and shores; and in truth all quantities of things that exist in the universe, either real or imaginary, he has first in his mind and then in his hands; and these things are of so great excellence that they beget a harmonious concord in one glance, as do the things of nature.

31.

We can safely say that those people are under a delusion who call that painter a good master who can only draw well a head or a figure. Certainly there is no great merit if, after studying a single thing during a whole lifetime, you attain to a certain degree of perfection in it. But knowing, as we do, that painting includes and comprehends all the works produced by nature, or brought about by the fortuitous action of man, and in fact everything that the eye can see, he seems to me to be a poor master who can only do one thing well. Now seest thou not how many and diverse acts are performed by men? Seest thou not how many various animals there are, and likewise trees, plants and flowers; what a variety of mountainous or level places, fountains, rivers, cities, public and private buildings, instruments suitable for human use; how many diverse costumes and ornaments and arts? All these things should be considered of equal effect and value when used by the man who can be called a good painter.

Painting and Nature

32.

If you despise painting, which is the only imitator of the visible works of nature, you will certainly despise a subtle invention which with philosophy and subtle speculation apprehends the qualities of forms, backgrounds, places, plants, animals, herbs and flowers, which are surrounded by light and shade. And truly this is knowledge and the legitimate offspring of nature, because painting is begotten by nature. But to be correct, we will say that it is the grandchild of nature, because all visible things are begotten by nature, and these her children have begotten painting. Therefore we shall rightly say that painting is the grandchild of nature and related to God.

33.

Were a master to boast that he could remember all the forms and effects of nature, he would certainly appear to me to be graced with great ignorance, inasmuch as these effects are infinite and our memory is not sufficiently

capacious to retain them. Therefore, O painter, beware lest in thee the lust of gain should overcome the honour of thy art, for the acquisition of honour is a much greater thing than the glory of wealth. Thus, for this and for other reasons which could be given, first strive in drawing to express to the eye in a manifest shape the idea and the fancy originally devised by thy imagination; then go on adding or removing until thou art satisfied; then arrange men as models, clothed or nude, according to the intention of thy work, and see that, as regards dimension and size, in accordance with perspective there is no portion of the work which is not in harmony with reason and natural effects, and this will be the way to win honour in thy art.

Painting & Sculpture

34.

I have myself practised the art of sculpture as well as that of painting, and I have practised both arts in the same degree. I think, therefore, that I can give an impartial opinion as to which of the two is the most difficult: the most perfect requires the greater talent, and is to be preferred.

In the first place sculpture requires a certain light, that is to say, a light from above, and painting carries everywhere with it its light and shade; sculpture owes its importance to light and shade. The sculptor is aided in this by the relief which is inherent in sculpture, and the painter places the light and shade, by the accidental quality of his art, in the places where nature would naturally produce it. The sculptor cannot diversify his work by the various colours of objects; painting is complete in every respect. The perspective of the sculptor appears to be altogether untrue; that of the painter can give the idea of a distance of a hundred miles beyond the picture. The sculptors have no aerial perspective; they can neither represent transparent bodies nor reflections, nor bodies as lustrous as mirrors, and other translucent objects, neither mists nor dark skies, nor an infinity of objects which it would be tedious to enumerate. The advantage [of sculpture] is that it is provided with a better defence against the ravages of time, although a picture painted on thick copper and covered over with white enamel, painted with enamel colours and then put in the fire again and baked, is equally resistant. Such a work as far as permanence is concerned exceeds sculpture. They may say that where an error is made it is not easy to correct it. It is poor reasoning to try and prove that the irremediability of an oversight renders the work more honourable. But I say to you that it will prove more difficult to mend

the mind of the master who commits such errors than to repair the work he has spoilt. We know well that an experienced and competent artist will not make mistakes of this kind; on the contrary, acting on sound rules, he will remove so little at a time that his work will be brought to a successful close. Again, the sculptor, if he works in clay or wax, can remove and add, and when the work is finished it can be easily cast in bronze, and this is the last and most permanent operation of sculpture, inasmuch as that which is merely of marble is liable to destruction, but this is not the case with bronze. Therefore the picture painted on copper, which with the methods of painting can be reduced or added to, is like bronze, which when it was in the state of a wax model could be reduced or added to. And if sculpture in bronze is durable, this copper and enamel work is more imperishable still; and while the bronze remains black and ugly, this is full of various and delectable colours of infinite variety, as we have described above. If you wish to confine the discussion to painting on panel I am content to pronounce between it and sculpture, saying, that painting is the more beautiful, the more imaginative and the more copious, and that sculpture is more durable, but has no other advantage. Sculpture with little labour shows what in painting seems to be a miraculous thing to do: to make impalpable objects appear palpable, to give the semblance of relief to flat objects, and distance to objects that are near. In fact painting is full of infinite resources of which sculpture cannot dispose.

35.

Sculpture is not a science, but a mechanical art, because it causes the brow of the artist who practises it to sweat, and wearies his body; and for such an artist the simple proportions of the limbs, and the nature of movements and attitudes, are all that is essential, and there it ends, and shows to the eye what it is, and it does not cause the spectator to wonder at its nature, as painting does, which in a plane by its science shows vast countries and far-off horizons.

36.

The only difference between painting and sculpture is that the sculptor accomplishes his work with the greater bodily fatigue, and the painter with the

greater mental fatigue. This is proved by the fact that the sculptor in practising his art is obliged to exert his arms and to strike and shatter the marble or other stone, which remains over and above what is needed for the figure which it contains, by manual exercise, accompanied often by profuse sweating, mingled with dust and transforming itself into dirt; and his face is plastered and powdered with the dust of the marble, so that he has the appearance of a baker, and he is covered with minute chips, and it appears as if snow had fallen on him, and his dwelling is dirty and full of chips and the dust of stone.

The contrary occurs in the case of the painter, — we are speaking of excellent painters and sculptors, — since the painter with great leisure sits before his work well clothed, and handles the light brush dipped in lovely colours. He wears what garments he pleases; his dwelling is full of beautiful pictures, and it is clean; sometimes he has music or readers of diverse and pleasant works, which, without any noise of hammers or other confused sounds, are heard with great pleasure.

37.

There can be no comparison between the talent, art and theory of painting and that of sculpture, which leaves perspective out of account, — perspective which is produced by the quality of the material and not of the artist. And if the sculptor says that he cannot restore the superabundant substance which has once been removed from his work, I answer that he who removes too much has but little understanding and is no master. Because if he has mastered the proportions he will not remove anything unnecessarily; therefore we will say that this disadvantage is inherent in the artist and not in the material. But I will not speak of such men, for they are spoilers of marble and not artists.

Artists do not trust to the judgement of the eye, because it is always deceptive, as is proved by him who wishes to divide a line into two equal parts by the eye, and is often deceived in the experiment; wherefore the good judges always fear — a fear which is not shared by the ignorant — to trust to their own judgement, and on this account they proceed by continually checking the height, thickness and breadth of each part, and by so doing accomplish no more than their duty. But painting is marvellously devised of most subtle analyses, of which sculpture is altogether devoid, since its range is of the narrowest. To the sculptor who says that his science is more lasting than that of painting, I answer that this permanence is due to the quality of the material and not to that of the sculptor,

and the sculptor has no right to give himself the credit for it, but he should let it redound to nature which created the material.

38.

Painting has a wider intellectual range and is more wonderful and greater as regards its artistic resources than sculpture, because the painter is by necessity constrained to amalgamate his mind with the very mind of nature and to be the interpreter between nature and art, making with art a commentary on the causes of nature's manifestations which are the inevitable result of its laws; and showing in what way the likenesses of objects which surround the eye correspond with the true images of the pupil of the eye, and showing among objects of equal size which of them will appear more or less dark, or more or less clear; and among objects equally low which of them will appear more or less low; or among those of the same height which of them will appear more or less high; or among objects of equal size placed at various distances one from the other, why some will appear more clearly than others. And this art embraces and comprehends within itself all visible things, which sculpture in its poverty cannot do: that is, the colours of all objects and their gradations; it represents transparent objects, and the sculptor will show thee natural objects without the painter's devices; the painter will show thee various distances with the gradations of colour producing interposition of the air between the objects and the eye; he will show thee the mists through which the character of objects is with difficulty descried; the rains which clouded mountains and valleys bring with them; the dust which is inherent to and follows the contention between these forces; the rivers which are great or small in volume; the fishes disporting themselves on the surface or at the bottom of these waters; the polished pebbles of various colours which are collected on the washed sands at bottom of rivers surrounded by floating plants beneath the surface of the water; the stars at diverse heights above us; and in the same manner other innumerable effects to which sculpture cannot attain.

39.

Sculpture lacks the beauty of colours, the perspective of colours; it lacks

perspective and it confuses the limits of objects remote from the eye, inasmuch as it represents the limits of objects that are near in the same way as those of distant objects; it does not represent the air which, interposed between the eye and the remote object, conceals that object but as the veils in draped figures, which reveal the naked flesh beneath them; it cannot represent the small pebbles of various colours beneath the surface of the transparent waters.

To the Painter

40.

And thou, painter, who desirest to achieve the highest excellence in practice, understand that unless thou build it on the solid foundations of nature, thou shalt reap but scant honour and gain by thy work; and if thy foundation is sound, thy works shall be many and good, and bring great honour to thee, and be of great profit.

41.

When the work exceeds the ideal of the artist, the artist makes scant progress; and when the work falls short of his ideal it never ceases to improve, unless avarice be an obstacle.

42.

He is a poor disciple who does not surpass his master.

Counsels

43.

He is a poor master whose work is exalted in his own opinion, and he is on the road to perfection in art whose work falls short of his ideal.

44.

Small rooms or dwellings help the mind to concentrate itself; large rooms are a source of distraction.

45.

The painter should be solitary, and take note of what he sees and reason with himself, making a choice of the more excellent details of the character of any object he sees; he should be like unto the mirror, which takes the colours of the objects it reflects. And this proceeding will seem to him to be a second nature.

The Painter in his Studio

46.

In order that the favourable disposition of the mind may not be injured by that of the body, the painter or the draughtsman should be solitary, and especially when he is occupied with those speculations and thoughts which continually rise up before the eye, and afford materials to be treasured by the memory.

If thou art alone, thou wilt belong to thyself only: if thou hast but one companion, thou wilt only half belong to thyself, and ever less in proportion to the indiscretion of his conduct; and if thou hast many companions, thou wilt encounter the same disadvantage. And if thou shouldst say: “I will follow my own inclination, I will withdraw into seclusion in order the better to study the forms of natural objects” — I say thou wilt with difficulty be able to do this, because thou wilt not be able to refrain from constantly listening to their chatter; and, not being able to serve two masters, thou wilt play the part of a companion ill, and still worse will be the evil effect on thy studies in art. And if thou sayest: “I will withdraw myself, so that their words cannot reach and disturb me” — I, with regard to this, say thou wilt be regarded as a madman; but seest thou not that by so doing thou wilt be alone also?

Advice to the Painter

47.

The mind of the painter must be like unto a mirror, which ever takes the colour of the object it reflects, and contains as many images as there are objects before it. Therefore realize, O painter, that thou canst not succeed unless thou art the universal master of imitating by thy art every variety of nature's forms, and this thou canst not do save by perceiving them and retaining them in thy mind; wherefore when thou walkest in the country let thy mind play on various objects, observe now this thing and now that thing, making a store of various objects selected and chosen from those of lesser value. And thou shalt not do as some painters, who, when weary of plying their fancy, dismiss their work from their mind and take exercise in walking for relaxation, but retain fatigue in the mind, which, though they see various objects, does not apprehend them, but often when they meet friends and relations and are saluted by them, they are no more conscious of them than if they had met empty air.

Precepts

48.

And thou, O painter, seek to bring about that thy works may attract those who gaze upon them and arrest them with great admiration and delight; and so that they may not attract and forthwith repel them, as the air does to him who in the night season leaps naked from his bed to gaze upon the cloudy and serene sky and forthwith is driven back by the cold, and returns to the bed whence he rose. But let thy works be like the air which draws men from their beds in the hot season, and retains them to taste with delight the cool of the summer; and he who will do well by his art will not strive to be more skilful than learned, nor let greed get the better of glory. Seest thou not among human beauties that it is the beautiful faces which stop the passers-by, and not the richness of their ornaments? And this I say to thee who adornest thy figures with gold and other rich ornaments: Seest thou not splendid, youthful beauties, who diminish their excellence by the excess and elaboration of their ornaments? Hast thou not seen women of the mountains dressed in rough and poor clothes richer in beauty than those who are adorned? Make no use of the affected arrangements and

headdresses such as those adopted by loutish maids, who, by placing one lock of hair more on one side than the other, credit themselves with having committed a great enormity, and think that the bystanders will forget their own thoughts to talk of them alone, and to blame them. For such persons have always the looking-glass and the comb, and the wind, which ruffles elaborate headdresses, is their worst enemy. In thy heads let the hair sport with the wind thou depictest around youthful countenances, and adorn them gracefully with various turns, and do not as those who plaster their faces with gum and make the faces seem as if they were of glass. This is a human folly which is always on the increase, and the mariners do not satisfy it who bring arabic gums from the East, so as to prevent the smoothness of the hair from being ruffled by the wind, — but they pursue their investigations still further in this direction.

49.

I cannot but mention among these precepts a new means of study, which, although it may seem trivial and almost ridiculous, is nevertheless extremely useful in arousing the mind to various inventions. It is as follows: when you look at walls mottled with various stains or stones made of diverse substances, if you have to invent some scene, you may discover on them the likeness of various countries, adorned with mountains, rivers, rocks, trees, plains, great valleys and hills in diverse arrangement; again, you may be able to see battles and figures in action and strange effects of physiognomy and costumes, and infinite objects which you could reduce to complete and harmonious forms. And the effect produced by these mottled walls is like that of the sound of bells, in the vibrating of which you may recognize any name or word you choose to imagine. I have seen blots in the clouds and in mottled walls which have stimulated me to the invention of various objects, and although the blots themselves were altogether devoid of perfection in any one of their parts, they lacked not perfection in their movement and circumstance.

50.

Obtain knowledge first, and then proceed to practice, which is born of knowledge.

Theory and Practice

51.

Knowledge is the captain, and practice the soldiers.

52.

The painter who draws by practice and by the eye, without the guide of reason, is like the mirror, which reflects all the objects which are placed before it and knows not that they exist.

53.

Many will consider they can reasonably blame me by alleging that my proofs are contrary to the authority of many men held in great esteem by their inexperienced judgements: overlooking the fact that my works are solely and simply the offspring of experience, which is the veritable master.

54.

They who are enamoured of practice without knowledge are like the mariner who puts to sea in a vessel without rudder or compass, and who navigates without a course. Practice should always be based on sound theory; perspective is the guide and the portal of theory, and without it nothing can be well done in the art of painting.

Course of Study

55.

The youth should first learn perspective, and then the measurements of every object; he should then copy from some good master to accustom himself to well-drawn forms, then from nature to acquire confirmation of the theories he has learnt; then he should study for a time the works of various masters, and finally attain the habit of putting into practice and producing his art.

56.

Mathematics, such as appertain to painting, are necessary to the painter, also the absence of companions who are alien to his studies: his brain must be versatile and susceptible to the variety of objects which it encounters, and free from distracting cares. And if in the contemplation and definition of one subject a second subject intervenes, — as happens when the mind is filled with an object, — in such cases he must decide which of the two objects is the more difficult of definition, and pursue that one until he arrives at perfect clearness of definition, and then turn to the definition of the other. And above all things his mind should be like the surface of the mirror, which shows as many colours as there are objects it reflects; and his companions should study in the same manner, and if such cannot be found he should meditate in solitude with himself, and he will not find more profitable company.

Perspective & Mathematics

57.

In the study of natural causes and reasons light affords the greatest pleasure to the student; among the great facts of mathematics the certainty of demonstration most signally elevates the mind of the student. Perspective must therefore be placed at the head of all human study and discipline, in the field of which the radiant line is rendered complex by the methods of demonstration; in it resides the glory of physics as well as of mathematics, and it is adorned with flowers of both these sciences.

The laws of those sciences which are capable of extensive analysis I will confine in brief conclusions, and according to the nature of the material I will interweave mathematical demonstrations, at times deducing results from causes, and at times tracing causes by results. I will add to my conclusions some which

are not contained in these, but which can be deduced from them, if the Lord, the Supreme Light, illuminates me, so that I may treat of light.

Of the Method of Learning

58.

When you will have thoroughly mastered perspective and have learnt by heart the parts and forms of objects, strive when you go about to observe. Note and consider the circumstances and the actions of men, as they talk, dispute, laugh or fight together, and not only the behaviour of the men themselves, but that of the bystanders who separate them or look on at these things; and make a note of them, in this way, with slight marks in your little note-book. And you should always carry this note-book with you, and it should be of coloured paper, so that what you write may not be rubbed out; but (when it is used up) change the old for a new one, since these things should not be rubbed out, but preserved with great care, because such is the infinity of the forms and circumstances of objects, that the memory is incapable of retaining them; wherefore keep these sketches as your guides and masters.

59.

These rules are only to be used in correcting the figures, since every man makes some mistakes in his first composition, and he who is not aware of them cannot correct them; but thou being conscious of thine errors wilt correct thy work and amend errors where thou findest them, and take care not to fall into them again. But if thou attemptest to apply these rules in composition thou wilt never finish anything, and confusion will enter into thy work. Through these rules thou shalt acquire a free and sound judgement, since sound judgement and thorough understanding proceed from reason arising from sound rules, and sound rules are the offspring of sound experience, the common mother of all the sciences and arts. Hence if thou bearest in mind the precepts of my rules thou shalt be able, merely by thy corrected judgement, to judge and recognize any lack of proportion in a work, in perspective, in figures or anything else.

Again of the Method of Learning

60.

I say that the first thing which should be learnt is the mechanism of the limbs, and when this knowledge has been acquired their actions should come next, according to the external circumstances of man, and thirdly the composition of subjects, which should be taken from natural actions, made fortuitously according to circumstances; and pay attention to them in the streets and public places and fields, and note them with a brief indication of outlines; that is to say, for a head make an O, and for an arm a straight or a bent line, and the same for the legs and body; and when thou returnest home work out these notes in a complete form. The adversary says that to acquire practice and to do a great deal of work, it is better that the first course of study should be employed in copying diverse compositions done on paper or on walls by various masters, and that thus rapidity of practice and a good method is acquired; to which I reply that this method will be good if it is based on works which are well composed by competent masters; and since such masters are so rare that but few of them are to be found, it is safer to go to nature, than to what to its deterioration is imitated from nature, and to fall into bad habits, since he who can go to the fountain does not go to the water-vessel.

Counsel to the Painter

61.

Every bough and every fruit is born above the insertion of its leaf, which serves it as a mother, giving it water from the rain and moisture from the dew which falls on it from above in the night, and often it shields them from the heat of the sun's rays. Therefore, O painter, who lackest such rules, be desirous, in order to escape the blame of those who know, of copying every one of thy objects from nature, and despise not study after the manner of those who work for gain.

On Anatomy

62.

And you who say that it would be better to see practical anatomy than drawings of it, would be right if it were possible to see all the things which are shown in such drawings in a single drawing, in which you, with all your skill, will not see nor obtain knowledge of more than a few veins; and to obtain true and complete knowledge of these veins I have destroyed more than ten human bodies, destroying all the other limbs, and removing, down to its minutest particles, the whole of the flesh which surrounds these veins, without letting them bleed save for the insensible bleeding of the capillary veins. And as one body did not suffice for so long a time I had to proceed with several bodies by degrees until I finished by acquiring perfect knowledge, and this I repeated twice to see the differences. And if you have a love for such things you may be prevented by disgust, and if this does not prevent you, you may be prevented by fear of living at night in company with such corpses, which are cut up and flayed and fearful to see; and if this does not prevent, you may not have a sufficient mastery of drawing for such a demonstration, and if you have the necessary mastery of drawing, it may not be combined with the knowledge of perspective; and if it were you might lack the power of geometrical demonstration, and the calculation of forces, and of the strength of the muscles, and perhaps you will lack patience and consequently diligence. As to whether these qualities are to be found in me or not the hundred and twenty books I have composed will pronounce the verdict Yes or No. Neither avarice nor negligence, but time has hindered me in these. Farewell.

On Study

63.

I have myself proved that it is useful when you are in bed in the dark to work with the imagination, summing up the external outlines of the forms previously studied or other noteworthy things apprehended by subtle speculation; and this is a laudable practice and useful in impressing objects on the memory.

On judging Pictures

64.

We are well aware that faults are more easily recognized in the works of

others than in our own, and often in blaming the small faults of others thou wilt ignore great ones in thyself. And to avoid such ignorance see that in the first place thy perspective be sound, then acquire a complete knowledge of the measurements of man and other animals, and of good architecture; that is to say, as far as the forms of buildings and other objects which are on the earth are concerned, and these are infinite in number. The more of them that thou knowest, the more praiseworthy will be thy work; and in cases where thou hast no experience do not refuse to draw them from nature.

Advice to the Painter

65.

Certainly while a man is painting he should not be loth to hear every opinion: since we know well that a man, although he be not a painter, is cognizant of the forms of another man, and will be able to judge them, whether he is hump-backed or has a shoulder too high or too low, or whether he has a large mouth or nose, or other defects. And if we know that men are capable of giving a correct judgement on the works of nature, much more ought we to acknowledge their competence to judge our faults, since we know how greatly a man may be deceived in his own work; and if thou art not conscious of this in thyself, study it in others and thou wilt profit by their faults. Therefore be desirous to bear with patience the opinions of others, and consider and reflect well whether he who blames has good ground or not to blame thee, and if thou thinkest that he has, amend thy work; and if not, act as though thou hadst not heard him, and if he should be a man thou esteemest show him by reasoning where his mistake lies.

66.

There is a certain generation of painters who, owing to the scantiness of their studies, must needs live up to the beauty of gold and azure, and with supreme folly declare that they will not give good work for poor payment, and that they could do as well as others if they were well paid. Now consider, foolish people! Cannot such men reserve some good work and say, "This is costly; this is moderate, and this is cheap work," and show that they have work at every price?

The Painter and the Mirror

67.

When thou wishest to see whether thy picture corresponds entirely with the objects thou hast drawn from nature, take a mirror and let the living reality be reflected in it, and compare the reflection with thy picture, and consider well whether the subject of the two images are in harmony one with another.

And above all thou shouldst take the mirror for thy master, — a flat mirror, since on its surface the objects in many respects have the same appearance as in painting. For thou seest that a painting done on a flat surface reveals objects which appear to be in relief, and the mirror consisting of a flat surface produces the same effect; the painting consists of one plane surface and the mirror likewise; the picture is impalpable, in so far as that which appears to be round and prominent cannot be grasped by the hands, and it is the same with the mirror; the mirror and the painting reveal the semblance of objects surrounded by light and shade; each of them appears to be at a distance from its surface.

And if thou dost recognize that the mirror by means of outlines, lights and shadows gives relief to objects, and since thou hast in thy colours lights and shadows stronger than those of the mirror, there is no doubt that if thou composest thy picture well, it will also have the appearance of nature when it is reflected in a large mirror.

The Painter's Mind

68.

The mind of the painter should continually transmute the figure of the notable objects which come before him into so many discourses; and imprint them in his memory and classify them and deduce rules from them, taking the place, the circumstances, the light and the shade into consideration.

The Variety of Nature

69.

I say that the universal proportions must be observed in the height of figures and not in their size, because in the admirable and marvellous things which appear in the works of nature there is no work of whatsoever character in which one detail is exactly similar to another; therefore, O thou imitator of nature, pay heed to the variety of features.

70.

Radically wrong is the procedure of some masters who are in the habit of repeating the same themes in the same episodes, and whose types of beauty are likewise the same, for in nature they are never repeated, so that if all the beauties of equal excellence were to come to life again they would compose a larger population than that now existing in our century, and since in the present century no one person is precisely similar to another, so would it be among the beauties mentioned above.

71.

You must depict your figures with gestures which will show what the figure has in his mind, otherwise your art will not be praiseworthy.

Mind and Expression

72.

No figure will be admirable if the gesture which expresses the passion of the soul is not visible in it. The most admirable figure is that which best expresses the passion of its mind.

73.

The good painter has two principal things to depict: man and the purpose of

his mind. The first is easy, the second is difficult, since he must do it by the gestures and movements of the limbs, and this is to be learnt from the dumb, who more than all other men excel in it.

The Dumb Man guides the Painter

74.

The figures of men have gestures which correspond to what they are doing, so that in seeing them you understand what they are thinking of and saying; and these will be learned well by him who will copy the gestures of the dumb, for they speak by the gestures of their hands, their eyes, their brows and their whole person, when they wish to express the purpose of their mind. And do not mock me because I suggest a dumb teacher for the teaching of an art of which he is himself ignorant, because he will teach you better by his gestures than all the others with their words. And despise not such advice because they are the masters of gesture, and understand at a distance what a man is talking of if he suits the actions of the hands to the words.

Advice to the Painter

75.

It is a great fault in painters to repeat the same movements, the same faces and manners of stuffs in one subject, and to let the greater part of his faces resemble their creator; and this has often been a source of wonder to me, for I have known some who in all their figures seem to have depicted themselves. And in the figures the actions and ways of the painter were visible. And if they are prompt in action and in their ways the figures are likewise prompt; and if the painter is pious, the figures with their twisted necks appear pious likewise, and if the painter is lazy the figures seem like laziness personified, and if the painter is deformed so are his figures, and if he is mad it is amply visible in figures of his subjects, which are devoid of intention and appear to be heedless of their action, some looking in one direction, some in another, as though they were dreaming; and therefore every manifestation in the picture corresponds to a peculiarity in the painter. And as I have often thought over the cause of this fault, it seems to me that we must conclude that the spirit which directs and governs everybody is

that which forms our intellect, or rather, it is our intellect itself. It has devised the whole figure of man according as it has thought fit that it should be, either with long or a short and turned-up nose, and thus it has determined its height and figure; and so powerful is the intellect that it gives motion to the arms of the painter and causes him to reproduce himself, since it appears to the spirit that this is the true method of portraying man, and he that does otherwise is in error. And should this spirit find any one who resembles its body, which it has formed, it loves it and becomes enamoured with it, and for this reason many men fall in love and marry wives which resemble themselves, and often the children which are born of the issue resemble their parents.

76.

The painter should portray his figure according to the measurements of a natural body, which shall be of universal proper proportions; in addition to this he should measure himself and see in which part his own figure varies greatly or less from the aforesaid pattern of excellence, and when he has ascertained this he should try his utmost to avoid the defects which exist in his own person in the figures he portrays.

And know that thou must contend with all thy might against this fault inasmuch as it is a defect which originated with the intellect; because the spirit which governs thy body is that which is thine own intellect, and it is inclined to take pleasure in works similar to that which it accomplished in forming its body. And this is the reason that there is no woman, however ugly, who does not find a lover, unless she be monstrous. So remember to ascertain the defects of thy person and to avoid reproducing them in the figures thou dost compose.

77.

That painter who has coarse hands will portray the like in his works, and the same thing will occur in every limb unless he avoids this pitfall by long study. Therefore, O painter, look well on that part of thy person which is most ugly, and by thy study make ample reparation for it, because if thou art bestial, bestial and without intellect will be thy figures, and similarly both the good and ill which thou hast in thee will be partially visible in thy compositions.

78.

Men and words are already made, and thou, painter, who knowest not how to make thy figures move, art like the orator who knows not how to employ his words.

79.

The movements of men are as varied as the circumstances which pass through their minds; and men will be more or less actuated by every circumstance in itself according as they are more or less powerful and according to age; because in the same circumstance an old man or a youth will make a different movement.

Power of Expression in Painting

80.

The imagination does not perceive such excellent things as the eye, because the eye receives the images or semblances from objects, and transmits them to the perception, and from thence to the brain; and there they are comprehended. But the imagination does not issue forth from the brain, with the exception of that part of it which is transmitted to the memory, and in the brain it remains and dies, if the thing imagined is not of high quality. And in this case poetry is formed in the mind or in the imagination of the poet, who depicts the same objects as the painter, and by reason of the work of his fancy he wishes to rival the painter, but in reality he is greatly inferior to him, as we have shown above. Therefore with regard to the work of fancy we will say that there is the same proportion between the art of painting and that of poetry as exists between the body and the shadow proceeding from it, and the proportion is still greater, inasmuch as the shadow of such a body at least penetrates to the brain through the eye, but the imaginative embodiment of such a body does not enter into the eye, but is born in the dark brain. Ah! What difference there is between imagining such a light in the darkness of the brain and seeing it in concrete

shape set free from all darkness.

If thou, O poet, dost represent the battle and its bloodshed enveloped by the obscure and dark air, amid the smoke of the terrifying and deadly engines, together with the thick dust which darkens the air, and the flight in terror of wretches panic-stricken by horrible death; in this case the painter will surpass thee, because thy pen will be used up before thou hast scarcely begun to describe what the art of the painter represents for thee immediately. And thy tongue shall be parched with thirst and thy body worn out with weariness and hunger before thou canst show what the painter will reveal in an instant of time. And in this painting there lacks nothing save the soul of the things depicted, and every body is represented in its entirety as far as it is visible in one aspect; and it would be a long and most tedious matter for poetry to enumerate all the movements of each soldier in such a war, and the parts of their limbs and their ornaments which the finished picture places before you with great accuracy and brevity; and to such a representation nothing is wanting save the noise of the engines, and the cries of the terrifying victors, and the screams and lamentations of those awe-stricken; neither again can the poet convey these things to the hearing.

We will say, therefore, that poetry is an art which is supremely potent for the blind, and the painting has the same result on the deaf. Painting, therefore, excels poetry in proportion as the sense to which it ministers is the nobler. The only true function of the poet is to represent the words of people who talk among each other, and these alone he represents to the hearing as if they were natural, because they are natural in themselves and created by the human voice; and in all other respects he is surpassed by the painter. Still more, incomparably greater is the width of range of painting than that of speech, because the painter can accomplish an infinity of things which speech will not be able to name for want of the appropriate terms. And seest thou not that if the painter wishes to depict animals and devils in Hell with what richness of invention he proceeds?

And I once chanced to paint a picture which represented a divine subject, and it was bought by the lover of her whom it represented, and he wished to strip it of its divine character so as to be able to kiss it without offence. But finally his conscience overcame his desire and his lust and he was compelled to remove the picture from his house. Now go thou, poet, and describe a beautiful woman without giving the semblance of the living thing, and with it arouse such desire in men! If thou sayest: I will describe then Hell and Paradise and other delights and terrors, — the painter will surpass thee, because he will set before thee things which in silence will [make thee] give utterance to such delight, and so terrify thee as to cause thee to wish to take flight. Painting stirs the senses more readily than poetry. And if thou sayest that by speech thou canst convulse a

crowd with laughter or tears, I rejoin that it is not thou who stirrest the crowd, it is the pathos of the orator, and his mirth. A painter once painted a picture which caused everybody who saw it to yawn, and this happened every time the eye fell on the picture, which represented a person yawning. Others have painted libidinous acts of such sensuality that they have incited those who gazed on them to similar acts, and poetry could not do this.

And if you write the description of certain deities the description will not be held in the same veneration as the picture of the Deity, because prayers and votive offerings will always be made to the picture, and many peoples from diverse countries and from across the Eastern seas will flock to it. And they will invoke the picture, and not the writing, for succour. Who is he who would not lose hearing, smell and touch rather than sight? Because he who loses his sight is like the man who is driven from the world, because he sees neither it nor anything else any longer. And this life becomes the sister of Death.

Landscapes

81.

I have been to see a variety of cloud effects, and lately over Milan towards Lake Maggiore I saw a cloud in the form of a huge mountain full of fiery scales, because the rays of the sun, which was already reddening and close to the horizon, tinged the cloud with its own colour. And this cloud attracted to it all the lesser clouds which were around it; and the great cloud did not move from its place, but on the contrary retained on its summit the light of the sun till an hour and a half after nightfall, such was its immense size; and about two hours after nightfall a great, an incredibly tremendous wind arose.

Vegetation of a Hill

82.

The grasses and plants will be paler in proportion as the soil which nourishes them is leaner and devoid of moisture; the earth is leaner and less rich in moisture on the rocks of which the mountains are formed. And the trees will be smaller and thinner in proportion as they are nearer to the summit of the mountain; and the soil is leaner in proportion as it is nearer to the said summit,

and it is richer in proportion as it is nearer the hollow valleys. Therefore, O painter, thou shalt represent rocks on the summits of the mountains — for they are composed of rocks — for the greater part devoid of soil, and the plants which grow there are small and lean and for the greater part withered and dry from lack of moisture, and the sandy and lean earth is seen through the faded plants; and the small plants are stunted and aged, exiguous in size, with short and thick boughs and few leaves; they cover for the greater part the rust-coloured and dry roots, and are interwoven in the strata and the fissures of the rugged rocks, and issue from trunks maimed by men or by the winds; and in many places you see the rocks surmounting the summits of the high mountains, covered with a thin and faded moss; and in some places their true colour is laid bare and made visible owing to the percussion of the lightnings of Heaven, whose course is often obstructed to the damage of these rocks.

And in proportion as you descend towards the base of the mountains the plants are more vigorous and their boughs and foliage are denser; and their vegetation varied according to the various species of the plants of which such woods are composed, and their boughs are of diverse arrangement and diverse amplitude of foliage, various in shape and size; and some have straight boughs like the cypress, and some have widely scattered and spreading boughs like the oak and the chestnut tree, and the like; some have very small leaves, others have a spare foliage like the juniper and the plane tree, and others; some plants born at the same time are divided by wide spaces, and others are united with no division of space between them.

How to represent Night

83.

That which is entirely devoid of light is all darkness; as the night is like this and you wish to represent a night subject, represent a great fire, so that the object which is nearest to the fire may be tinged with its colour, since the object which is nearest the fire will participate most in its nature. And as you will make the fire red, all the objects which it illumines must be red also, and those which are farther off from the fire will be dyed to a greater extent by the dark colour of night. The figures which are between you and the fire appear dark from the obscurity of the night, not from the glow of the firelight, and those which are at the side are half dark and half ruddy, and those which are visible beyond the edge of the flames will be altogether lighted up by the red glow against a black

background. As to their action, make those which are near shield themselves with their hands and cloaks against the intense heat with averted faces as though about to flee; with regard to those who are farther off, represent them chiefly in the act of raising their hands to their eyes, dazzled by the intense glare.

How to represent Storm

84.

If you wish to represent well a storm, consider and weigh its effects when the wind, blowing across the surface of the sea and the earth, removes and carries with it those things which are not stable in the universal drift. And in order to represent this storm adequately, you must in the first place represent tattered and rent clouds rushing with the rushing wind, accompanied by sandy dust caught up from the seashores, and boughs and leaves torn up by the force and fury of the wind, and dispersed in the air with many other light objects. The trees and the plants bent towards the earth almost seem as though they wished to follow the rushing wind, with their boughs wrenched from their natural direction and their foliage all disordered and distorted. Of the men who are to be seen, some are fallen and entangled in their clothes and almost unrecognizable on account of the dust, and those who remain standing may be behind some tree, clutching hold of it so that the wind may not tear them away; others, with their hands over their eyes on account of the dust, stoop towards the ground, with their clothes and hair streaming to the wind. The sea should be rough and tempestuous, and full of swirling eddies and foam among the high waves, and the wind hurls the spray through the tumultuous air like a thick and swathing mist. As regards the ships that are there, you will depict some with torn sails and tattered shreds fluttering through the air with shattered rigging; some of the masts will be split and fallen, and the ship lying down and wrecked in the raging waves; some men will be shrieking and clinging to the remnants of the vessel. You will make the clouds driven by the fury of the winds and hurled against the high summits of the mountains, and eddying and torn like waves beaten against rocks; the air shall be terrible owing to deep darkness caused by the dust and the mist and the dense clouds.

How to describe a Battle

85.

In the first place you must represent the smoke of the artillery mingled with the air, and the dust, and tossed up by the stampede of the horses and the combatants. And you must treat this confusion in this way: dust being an earthly thing has weight, and although owing to its fineness it is easily lifted up and mingled with the air, it nevertheless falls readily to the earth again, and it is its finest part which rises highest, therefore that part will be the least visible and will seem to be almost of the same colour as the air; the higher the smoke, which is mingled with the dusty air, rises towards a certain height, the more it will seem like a dark cloud, and at the summit the smoke will be more visible than the dust. The smoke will assume a bluish colour, and the dust will retain its colour: this mixture of air, smoke and dust will seem much brighter on the side whence the light proceeds than on the opposite side; the more densely the combatants are enveloped in this confusion the less distinctly will their lights and shadows be visible. You must cast a glowing light on the countenances and the figures, the atmosphere, the musketeers and those who are near them, and this light diminishes in proportion as the distance between it and its cause increases; and the figures which are between you and the light will appear dark against a bright background, and their legs will be less visible in proportion as they are nearer to the earth, because the dust there is coarsest and thickest. And if you depict horses galloping beyond the crowd, make little clouds of dust, distant one from the other in proportion to the strides made by the horses, and the cloud which is farthest away from the horse will be the least visible; it must be high, scattered and thin, and the nearer clouds will be more conspicuous, smaller and denser. The air must be full of arrows falling in every direction: some flying upwards, some falling, some on the level plane; and smoke should trail after the flight of the cannon-balls. The foremost figures should have their hair and eyebrows clotted with dust; dust must be on every flat portion they offer capable of retaining it. The conquerors you should make as they charge, with their hair and the other light things appertaining to them streaming to the wind, their brows contracted and the limbs thrust forward inversely, that is, if the right foot is thrust forward the left arm must be thrust forward also. And if you portray a fallen man you must show where he has slipped and been dragged through the blood-stained mud, and around in the wet earth you must show the imprint of the feet of men and the hoofs of horses that have passed there. You will also represent a horse dragging its dead master, and in the wake of the body its track, as it has been dragged along through the dust and the mud; you must make the

vanquished and beaten pale, their brows knit and the skin surmounting the brow furrowed with lines of pain. On the sides of the nose there must be wrinkles forming an arch from the nostrils to the eyes and terminating at the commencement of the latter; the nostrils should be drawn up, whence the wrinkles mentioned above; the arched lips show the upper row of teeth. The teeth should be apart, as with crying and lamentation. One hand shields the frightened eyes, the palm being held towards the enemy; the other [hand] rests on the ground to sustain the raised body. You shall portray others shouting in flight with their mouths wide open; you must depict many kinds of weapons lying at the feet of the combatants, such as broken shields, lances, shattered swords and other similar objects; you must portray dead men, some half covered, some entirely covered, by the dust which is mingled with the spilt blood and converted into red mud, and the blood is seen by its colour flowing in a sinuous stream from the body to the dust; others in their death-agony are grinding their teeth, rolling their eyes and clenching their fists against their bodies and their distorted legs. Some might be represented disarmed and thrown by the enemy, turning upon him with teeth and nails to wreak cruel and sharp revenge; a riderless horse might be represented charging with his mane streaming to the wind amidst the enemy, and inflicting great damage with his hoofs. Some maimed man might be seen fallen to the earth and protecting himself with his shield, while the enemy, bending over him, tries to kill him. You might show a number of men fallen together over a dead horse. You would see some of the conquerors leaving the battle and issuing from the crowd, clearing with their hands their eyes and cheeks of the mud made by the watering of their dust-bespattered eyes. You would see the reserves standing full of hope and caution, with brows alert, shading them with their hands and gazing through the thick and confused darkness, attentive to the orders of their captain; and likewise the captain, with his staff raised, is rushing towards these reserves and points out to them the spot where they are needed; and you may add a river with horses charging into it and stirring up the water all round them into seething waves of mixed foam and water, which is spurted into the air and among the legs and bodies of the horses. And there must not be a level place that is not trampled with gory footsteps.

Envy

Envy offends with false infamy, that is to say, by detraction which frightens virtue. Envy must be represented with the hands raised to heaven in contempt, because if she could she would use her power against God. Make her face covered with a goodly mark; show her as wounded in the eye by a palm-branch, and wounded in the ear by laurel and myrtle, to signify that victory and truth offend her. Draw many thunderbolts proceeding from her as a symbol of her evil-speaking. Make her lean and shrivelled up, because she is continual dissolution. Make her heart gnawed by a swelling serpent. Make her a quiver full of tongues for arrows, because she often offends with these. Make her a leopard's skin, because the leopard kills the lion through envy and by deceit. Place a vase in her hand full of flowers, and let it be full also of scorpions, toads and other reptiles. Let her ride Death, because Envy, which is undying, never wearies of sovereignty. Make her a bridle loaded with divers arms, because her weapons are all deadly. As soon as virtue is born it begets envy which attacks it; and sooner will there exist a body without a shadow than virtue unaccompanied by envy.

Fame

87.

Fame alone rises towards heaven, because God looks with favour on virtuous things; infamy must be represented upside down, because its works are contrary to God and move towards hell. Fame should be depicted covered with tongues instead of with feathers and in the form of a bird.

The Expressive Picture

88.

A picture or a representation of human figures should be done in such a way that the spectator can easily recognize the purpose that is in their minds by their attitudes. If you have to represent a man of high character, let his gestures be such as harmonize with fair words; likewise, if you have to represent a man of low character, let his gestures be fierce, let him thrust his arms towards the listener, and let his head and chest be thrust forward in front of his feet, following the hands of the speaker. It is thus with a dumb man, who seeing two

speakers, although he is deprived of hearing, nevertheless, owing to the attitudes and gestures of the speakers, understands the subject of their argument. I once saw at Florence a man who had become deaf by an accident, who, if you spoke loud to him, did not understand you, but if you spoke gently, without making any noise, he understood you merely by the movement of the lips. Now you can say, Does not one who talks loudly move his lips like one who talks softly? In regard to this I leave experiment to decide: make a man speak gently to you and note his lips.

The Ages of Man

89.

How the ages of man should be depicted: that is, infancy, childhood, youth, manhood, old age, decrepitude. How old men should be depicted with lazy and slow movements, their legs bent at the knees when they stand still, and their feet placed parallel and apart, their backs bent, their heads leaning forward and their arms only slightly extended.

How women should be represented in modest attitudes, their legs close together, their arms folded together, their heads bent and inclined to one side. How old women should be represented with eager, vehement and angry gestures, like the furies of Hades; the movement of the arms and the head should be more violent than that of the legs. Little children with ready and twisted movements when sitting, and when standing up in shy and timid attitudes.

90.

You will do as follows if you wish to represent a man talking to a number of people: you must consider the matter which he has to treat, and suit his action to the subject; that is to say, if the matter is persuasive, let his action be appropriate to it; if the matter is argumentative, let the speaker hold one finger of the left hand with two fingers of the right hand, closing the two smaller ones, and with his face turned towards the people and his mouth half open, let him seem to be about to speak, and if he is sitting let him appear as though about to rise, with his head forward; if you represent him standing up, let him lean slightly forward,

with his body and head towards the people. You must represent the people silent and attentive, looking at the orator's face with gestures of admiration, and depict some old men with the corners of their mouths pulled down in astonishment at what they hear, their cheeks drawn in and full of lines, their eyebrows raised, and thus causing a number of wrinkles on the forehead; again, some must be sitting with the fingers of their hands clasped and resting on their knee; another, a bowed old man, with one knee crossed over the other, and on the knee let him hold his hand, and let his other elbow rest on his hand, and let the hand support his bearded chin.

91.

You must represent an angry man holding some one by the ear, beating his head against the ground, with one knee on his ribs, his right arm raising his fist in the air; his hair must be dishevelled, his eyebrows low and narrow, his teeth clenched and the two corners of his mouth set, his neck swelled and [his brow] wrinkled and bent forward as he leans over his enemy.

92.

The desperate man must hold a knife and must have torn open his garments, and with one hand he must be tearing open the wound; and you must represent him with extended feet and the legs slightly bent and his body leaning towards the earth, his hair flying and dishevelled.

Notes on the Last Supper

93.

One who was in the act of drinking leaves his glass in its place, and turns his head towards the speaker. Another, twisting the fingers of his hands together, turns with stern brows to his companions. Another, with his hands spread out, shows their palms, and shrugs his shoulders towards his ears; his mouth

expresses amazement. Another speaks in the ear of his neighbour, and he, as he listens to him, turns towards him, lending him his ear, while he holds a knife in one hand and a piece of bread in the other, half cut through by the knife. Another, in turning with a knife in his hand, has upset a glass on the table. Another lays his hands on the table and looks fixedly. Another puffs out his cheeks, his mouth full. Another leans forward to see the speaker, shading his eyes with his hand. Another draws back behind him who is leaning forward and sees the speaker between the wall and the man who is leaning forward.

III. THOUGHTS ON SCIENCE

There is no human experience that can be termed true science unless it can be mathematically demonstrated. And if thou sayest that the sciences which begin and end in the mind are true, this cannot be conceded, but must be denied for many reasons, and firstly because in such mental discourses experience is eliminated, and without experience there can be no certainty.

Theory and Practice

2.

You must first propound the theory and then explain the practice.

3.

Let no man who is not a mathematician read the principles of my work.

4.

In the course of scientific exposition the demonstration of a general rule derived from a previous conclusion is not to be censured.

Certainty of Mathematics

5.

He who blames the supreme certainty of mathematics feeds on confusion and will never be able to silence the contradictions or sophistical sciences which lead to an everlasting clamour.

Of Science

6.

There is no certainty [in science] where one of the mathematical sciences cannot be applied, or in those [sciences] which are not in harmony with mathematics.

From Leonardo's Dictionary

7.

Syllogism: to speak doubtfully.

Sophism: to speak confusedly; falsehood for truth.

Theory: knowledge without practice.

Definition of Science

8.

Science is that discourse of the mind which derives its origin from ultimate principles beyond which nothing in nature can be found which forms a part of that science: as in the continued quantity, that is to say, the science of geometry, which, starting from the surfaces of bodies, has its origin in the line, which is the end of the superficies; and we are not satisfied by this, because we know that the line terminates in the point, and the point is that which is the least of things. Therefore the point is the first principle of geometry, and nothing else can exist either in nature or in the human mind from which the point can issue. Because if you say that the contact between a surface and the extreme point of an iron instrument is the creation of the point, it is not true; but let us say that this point of contact is a superficies which surrounds its centre, and in the centre the point dwells. And such a point is not a part of the substance of the superficies, neither it nor all the points of the universe can, even if combined, — it being granted that they could be combined, — compose any part of a superficies. And granted, as you imagined, a whole composed of a thousand points, if we divide any part of this quantity of a thousand, we can very well say that this part shall equal its

whole; and this we can prove by zero, or naught, that is, the tenth figure of arithmetic, which is represented by a cipher as being nothing, and placed after unity it will signify 10, and if two ciphers are placed after unity it will signify 100, and thus the number will go on increasing by ten to infinity whenever a cipher is added, and the cipher in itself is worth nothing more than naught, and all the naughts in the universe are equal to one naught alone, in regard to their substance and value.

True Science based on the Testimony of the Senses

9.

Knowledge which is the issue of experience is termed mechanical; that which is born and ends in the mind is termed scientific; that which issues from science and ends in manual work is termed semi-mechanical. But I consider vain and full of error that science which is not the offspring of experience, mother of all certitude, and which does not result in established experience, that is to say, whose origin, middle and end do not pass through any of the five senses. And if we doubt of everything we perceive by the senses, should we not doubt much more of what is contrary to the senses, such as the existence of God and of the soul, and similar matters constantly under dispute and contention?

And it is truly the case that where reason is lacking it is supplemented by noise, which never happens in matters of certainty. On account of this we will say that where there is noise there is no true science, because truth has one end only, which, when it is made known, eternally silences controversy, and should controversy come to life again, it is lying and confused knowledge which is reborn, and not certainty. But true science is that which has penetrated into the senses through experience and silenced the tongue of the disputers, and which does not feed those who investigate it with dreams, but proceeds from the basis of primary truths and established principles successively and by true sequence to the end; as, for instance, what comes under the heading of elementary mathematics, that is, numeration and measurement, termed arithmetic and geometry, which treat with the highest truth of the discontinued and continued quantity. Here there will be no dispute as to whether twice three make more or less than six, nor whether two angles of a triangle are less than two right angles, but eternal silence shall ignore all controversy, and the devotees of the true science will finish their studies in peace, which the lying mental sciences cannot do. And if thou sayest that true and established science of this kind is a species

of mechanics, because they can only be completed by the hand, I will say the same of all the arts, such as that which passes through the hand of the sculptor, which is a kind of drawing, a part of painting; and astrology and the other sciences pass through manual operation, but they are mental in the first place, as painting, which first of all exists in the mind of the composer, and cannot attain to fulfilment without manual labour. With regard to painting, its true and scientific principles must be established: what constitutes a shaded body, what constitutes a primary shade, a derivative shade, what constitutes light: that is, darkness, light, colour, size, shape, position, distance, propinquity, motion, rest, which are comprehended by the mind only, and without manual labour. And this is the science of painting which remains in the mind of those who meditate on it, from which issues the work in due time, and is infinitely superior to the aforesaid contemplation or science.

Mechanics

10.

Mechanics are the paradise of scientific mathematics, because with them we arrive at the fruits of mathematics.

Mechanics and Experience

11.

Experience is indispensable for the making of any instrument.

12.

Proportion is not only to be found in figures and measurements, but also in sound, weight, time and position, and in whatever power which exists.

Reason and Experience

13.

The power of the projecting force increases in proportion as the object projected is smaller; the acceleration of the motion increases to infinity proportionately to this diminution. It would follow that an atom would be almost as rapid as the imagination or the eye, which in a moment attains to the height of the stars, and consequently its voyage would be infinite, because the thing which can be infinitely diminished would have an infinite velocity and would travel on an infinite course (because every continuous quantity is divisible to infinity). And this opinion is condemned by reason and consequently by experience.

Thus, you who observe rely not on authors who have merely by their imagination wished to be interpreters between nature and man, but on those alone who have applied their minds not to the hints of nature but to the results of their experience. And you must realize the deceptiveness of experiments; because those which often appear to be one and the same are often different, as is shown here.

Effects correspond to the Force of their Cause

14.

A spherical body which possesses a dense and resisting superficies will move as much in the rebound resulting from the resistance of a smooth and solid plane as it would if you threw it freely through the air, if the force applied be equal in both cases.

Oh, admirable justice of thine, thou first mover! thou hast not permitted that any tone should fail to produce its necessary effects, either as regards order or quantity. Seeing that a force impels an object which it overcomes a distance of one hundred arms' length, and if in obeying this law it meets with resistance, thou hast ordained that the force of the shock will cause afresh a further movement, which in its various bounds recuperates the whole sum of the distance it should have travelled. And if you measure the distance accomplished by the aforesaid bounds you will find that they equal the length of distance through which a similar object set in motion by an equal force would travel freely through the air.

15.

Every action must be caused by motion.

16.

Motion is the cause of all life.

Of Force

17.

What is force? Force, I say, is a spiritual virtue, an invisible power, which by accidental external violence is caused by motion, and communicated and infused into bodies which are inert by nature, giving them an active life of marvellous power.

18.

What is force? I say that force is a spiritual, incorporate and invisible power, which for a brief duration is produced in bodies that by accidental violence are displaced from their natural state of inertia.

Origin of Force

19.

Force arises from dearth or abundance; it is the child of physical motion and the grandchild of spiritual motion, and the mother and origin of gravity. Gravity is confined to the elements of water and earth, and this force is infinite, because infinite worlds could be moved by it if instruments could be made by which the force could be generated. Force, with physical motion, and gravity, with resistance, are the four accidental powers by which all mortal things live and die. Force has its origin in spiritual motion, and this motion, flowing through the limbs of sentient animals, enlarges their muscles, and thus enlarged the muscles

are shrunk in length and contract the tendons with which they are connected, and this is the cause of the strength in human limbs. The quality and quantity of the strength of a man can generate a further force, which will increase in proportion to the duration of the motions produced by them.

Aspects of Force

20.

Gravity, force and casual motion together with resistance are the four external powers by which all the visible actions of man live and die.

Of Inertia

21.

A motion tends to be continuous; a body set in motion continues to move as long as the impression of the motive power lasts in it.

Can Man imitate a Bird's Flight?

22.

The bird is an instrument which operates by mathematical laws, and man can reproduce all the movements of this instrument, but cannot attain to the intensity of its power; and can only succeed in acquiring balance. Thus we will say that such an instrument constructed by man lacks only the soul of the bird, and the soul of man must counterfeit the soul of the bird. The spirit in the frame of the bird doubtless would respond to needs of that frame better than would the spirit of man, whose frame is different, more especially in the almost insensible motions of balance; and since we see the bird make provision for the many sensible varieties of movement, we can conclude by such experience that man can acquire knowledge of the more markedly sensible of these movements, and that he will be able to make ample provision against the destruction of that instrument of which he has made himself the spirit and the guide.

Of Inertia

23.

A natural and continuous motion seeks to preserve its course along the line of its starting-point, that is to say, let us call starting-point whatever place in which it varies.

24.

Everything maintains itself by motion. And if it were possible to describe a diameter of air on the sphere of the earth, like to a well, which would extend from one superficies to the other, and if a weighty body were dropped into this well, the body would seek to remain stationary at the centre, but so strong would be the impetus that for many years it would prevent it from so doing.

Transmission of Motion

25.

Impetus is a virtue created by motion and communicated by the motive force to the object moved, and this object acquires motion in proportion to the energy of the impetus.

Matter is Inert

26.

No lifeless matter moves of itself, but its motion is caused from without.

27.

All elements displaced from their natural place seek to return to it, and more especially fire, water and earth.

28.

All matter universally seeks to maintain itself in its natural state; hence, water in motion seeks to maintain its course according to the force by which it is propelled, and if it meets with opposition it finishes the length of the course it began in a circular and reflex motion.

Conception of Energy

29.

Impetus is the impression of motion conveyed by the motive power to the object moved. Every impression tends to permanence or seeks to attain permanence. That every impression seeks after permanence is proved by the impression made by the sun on the eye which regards it, and in the impression of sound made by the hammer which strikes a bell. Every impression seeks after permanence, as is shown in the image of impetus communicated to the object moved.

30.

A weight seeks to fall to the centre of the earth by the most direct way.

In Praise of the Sun

31.

If you look at the stars, warding off the rays (as may be done by looking through a small hole made by the extreme point of a fine needle placed so as almost to touch the eye), they will appear so small as to seem as though nothing

could be smaller; it is owing to their great distance that they appear so small, for many of them are very many times larger than the star which is the earth with its water. Now reflect what appearance this our star must have from so great a distance, and then consider how many stars might be placed — both in longitude and latitude — between those stars which are sown in the dark space. I can never refrain from blaming many of the ancients who said that the size of the sun was no greater than it appears; among whom was Epicurus. I believe he founded his reasoning on a light placed in our atmosphere equidistant from the centre of the earth, which, to any one looking at it, never appears to diminish in size from whatever distance it is seen.

32.

I shall reserve the reasons of its size and power for later. But I greatly marvel that Socrates should have depreciated such a body, and that he should have said that it resembled an incandescent stone; and he who opposed him as regards this error acted rightly. But I wish I had words to blame those who seek to exalt the worship of men more than that of the sun, since in the universe there is no body of greater magnitude and power to be seen than the sun. And its light illumines all the celestial bodies which are distributed throughout the universe; and the vital spark descends from it, because the heat which is in living beings comes from the soul, and there is no other centre of heat and light in the universe, as will be shown later; and it is certain that those who have elected to worship men as gods — as Jupiter, Saturn, Mars, &c. — have fallen into a profound error, since even if a man were as great as our earth, he would have the appearance of a little star, which appears like a dot in the universe; and moreover these men are mortal, and decay and corrupt in their sepulchres.

33.

Epicurus perhaps saw the shadows of columns on the walls in front of them equal to the diameter of the column which cast the shadow; and since the breadth of the shadows are parallel from beginning to end he considered that he might infer that the sun also was directly opposite to this parallel, and consequently no

broadier than the column; and he did not perceive that the diminution of the shadow was insensibly small owing to the great distance of the sun. If the sun were smaller than the earth, the stars in a great portion of our hemisphere would be without light — in contradiction to Epicurus, who says the sun is only as large as it appears to be.

34.

Epicurus says the sun is the size it seems to be; hence, as it seems to be a foot in breadth, we must consider that to be its size. It follows that when the moon eclipses the sun, the sun ought not to appear the larger, as it does; hence, the moon being smaller than the sun, the moon must be less than a foot in breadth, and consequently when the earth eclipses the moon it must be less than a foot by a finger's breadth; inasmuch as if the sun is a foot in breadth, and the earth casts a conical shadow on the moon, it is inevitable that the luminous cause of the conical shadow must be greater than the opaque body which causes it.

35.

Measure how many times the diameter of the sun will go into its course in twenty-four hours. And thus we can see whether Epicurus was correct in saying the sun was only as large as it appeared to be; for as the apparent diameter of the sun is about a foot, and as the sun would go a thousand times into its course in twenty-four hours, it would have travelled a thousand feet, that is, three hundred arms' length, which is the sixth of a mile. Thus the course of the sun during twenty-four hours would have been the sixth part of a mile, and this venerable snail, the sun, would have travelled twenty-five arms' length in an hour.

The Sun's Heat

36.

They say that the sun is not hot because it is not the colour of fire but whiter and clearer. And the answer to this is that when molten bronze is hottest it

resembles the colour of the sun, and when it is less hot it has the colour of fire.

37.

It is proved that the sun is by nature hot and not cold, as has already been stated. If rays of fire play on a concave mirror when it is cold, the rays refracted by the mirror will be hotter than the fire. The rays emitted from a sphere of glass filled with cold water, which are reflected from a fire, will be warmer than the fire. It follows from these two experiments that the heat of the rays reflected by the mirror or the sphere of cold water are hot by virtue, and not because the mirror or the sphere is hot; and in this case it occurs that the sun, passing through these bodies, heats them by its virtue. And owing to this they have inferred that the sun is not hot, — which by the aforesaid experiments has been proved to be exceedingly hot, by the experiment of the mirror and the sphere, which are cold in themselves, and reflect the hot rays of the fire and render them hotter, because the first cause is hot; and the same thing occurs as regards the sun, which, being hot in itself, and passing through these cold mirrors, refracts great heat. It is not the light of the sun which gives warmth, but its natural heat.

Rays of the Sun

38.

The rays of the sun pass through the cold region of the air without any change being effected in their nature, they pass through glasses full of cold water without suffering change; through whatever transparent spot they pass, it is as though they passed through so much air.

Light of the Stars

39.

Some writers allege that the stars shine of themselves, saying that if Venus and Mercury did not shine of themselves, when their light comes between them and the sun they would darken as much of the sun as they could hide from our

eye; this is false, because it is proved that a dark body placed against a luminous body is enveloped and altogether covered by the lateral rays of the remaining part of that body, and thus remains invisible; as may be proved when the sun is seen through the boughs of a leafless tree at a long distance, the boughs do not hide any portion of the sun from our eyes. The same thing occurs with the above-mentioned planets, which, though they have no light in themselves, do not, as has been said, hide any portion of the sun from our eyes.

Second proof. They say that the stars shine most brightly at night in proportion as they are high; and that, if they did not shine of themselves, the shadow cast by the earth between them and the sun would darken them, since they would not see nor be seen by the sun. But these have not taken into consideration that the conical shadow of the moon does not reach many of the stars, and even for those it does reach the shadow is diminished to such an extent that it covers very little of the star, and the remaining part is illumined by the sun.

On the Nature of the Moon

40.

The moon having density and gravity, how does it stand?

41.

- i. No very light object is opaque.
- ii. Nothing light can remain beneath that which is heavier.
- iii. Whether the moon is the centre of its elements or not. And if it has no fixed position like the earth in the centre of its elements, why does it not fall to the centre of our elements? And if the moon is not in the centre of its elements and does not fall, it must then be lighter than any other element. And if the moon is lighter than the other elements, why is it opaque and not transparent?

42.

No body which has density is lighter than the air. Having proved that the part

of the moon which shines consists of water which mirrors the body of the sun and reflects for us the splendour it receives from the sun, and that if there were no waves in these waters, it would appear small, but almost as bright as the sun — it must now be shown whether the moon is a heavy or a light body; if it is a heavy body — admitting that from the earth upwards with every grade of distance lightness must increase, so that water is lighter than earth, air is lighter than water, and fire lighter than air, and so on in succession — it would seem that if the moon had density, as it has, it must have gravity, and if it has gravity the space in which it lies could not contain it, and consequently it would fall towards the centre of the universe and be joined to the earth, or if not the moon itself, its waters would fall from the moon and strip it and fall towards the centre, leaving the moon bare and lustreless; whence, as this could not happen, as reason would tell us, it is manifest that the moon is surrounded by its elements, that is to say, water, air and fire, and thus it sustains itself by itself in that space as our earth is suspended with its elements in this part of space; heavy bodies act in their elements there just as other heavy bodies act in ours.

On the Harmony of the Spheres

43.

A sound is produced by the movement of the air in friction against a dense body, and should it be produced by two weighty bodies it is owing to the atmosphere which surrounds them, and this friction consumes the bodies, so that it follows that the spheres in their friction, owing to there being no atmosphere between them, do not generate sound. And if this friction were a fact, during the many centuries the spheres have revolved they would be consumed by the immense velocity expended daily; and even if they produce sound, the sound could not travel, because the sound caused by percussion under water is scarcely noticeable, and it would be less than noticeable in the case of dense bodies. The friction of polished bodies produces no sound, and similar result would be produced in the contact or friction of the spheres; and if the spheres are not polished in their contact and friction, it follows that they are rough.

Again, their contact is not continuous; this being the case a vacuum is produced, which it has been proved does not exist in nature. Therefore we conclude that friction would have consumed the ends of each sphere, and in proportion as a sphere has a greater velocity in the centre than at the poles, it would be consumed to a higher degree at the centre than at the poles; and then

the friction would cease, and the sound would cease also, and the spheres would cease to revolve unless one sphere revolved eastward and the other northward.

44.

Worlds gravitate in the midst of their own elements. The yellow or yolk of an egg remains in the middle of the albumen without moving on either side, and is lighter or heavier or equal to this albumen; and if it is lighter it ought to rise above all the albumen and stop in contact with the shell of the egg; and if it is heavier it ought to sink; and if it is equal to it, it can stand at one of the ends as well as in the centre or below.

The Earth appears a Star

45.

The object of my book is to prove that the ocean, with the other seas, by means of the sun causes our world to shine like the moon and to appear as a star to other worlds; and this I will prove.

The Earth a Star

46.

In your discourse you must prove that the earth is a star like the moon, and thus you will bear witness to the glory of our universe! And thus you must discourse on the size of many stars.

47.

How the earth is a star. The earth, in the midst of the sphere of water which clothes the greater part of it, taking its light from the sun and shining in the universe like the other stars, shows itself to be a star as well.

To prove the Earth a Star

48.

First of all define the eye; then show how the twinkling of a star exists really in the eye, and why one star should twinkle more than another, and how the rays of the stars are born in the eye. Say, that if the twinkling of the stars were, as it appears to be, really in the stars, that this twinkling appears to extend in proportion to the body of the star. The star, therefore, being larger than the earth, this motion made in an instant of time would in its velocity double the size of the star. Then prove that the surface of the atmosphere, contiguous to fire and the surface of fire, where it ends, is the point in which the rays of the sun penetrate and bear the image of the celestial bodies which are large when they rise and set, and small when they are on the meridian.

Earth not the Center of Universe

49.

The earth is not the centre of the orbit of the sun, nor the centre of the universe, but in the centre of its companion elements and united with them; and if any one were to stand on the moon when the moon and the sun are beneath us, our earth, with its element of water, would appear and shine for him just as the moon appears and shines for us.

50.

The earth, shining like the moon, has lost a great part of its ancient splendour by the decrease of the waters.

51.

Nothing is generated in a place where is no sentient vegetable and rational life; feathers grow on birds and change every year; coats grow on animals and are changed every year, with some exceptions, like the lion's beard and the cat's fur, and such; grass grows in the fields and leaves on the trees; and every year they are renewed in great part. Thus we can say that the spirit of growth is the soul of the earth, the soil its flesh, the ordered arrangement of rocks its bones, of which mountains are formed, the tufa its tendons; its blood the veins of water which surround its heart, which is the ocean; its breathing and increase and decrease of blood in the pulses the ebb and flood of the sea; and the heat of the spirit of the world is fire which pervades the earth, and the vital soul dwells in the fires which from various apertures of the earth issue in springs and sulphur minerals and volcanoes, as at Mount Etna in Sicily and in many other places.

52.

The ancients called man the world in miniature, and certainly the name is a happy one, because man being composed of earth, water, air and fire, the body of the earth resembles the body of man. As man has in him bones for the support and framework of his flesh, likewise in the world the rocks are the supports of the earth; as man has in him a pool of blood in which the lungs rise and fall in their breathing, so the body of the earth has its ocean which rises and falls every six hours as if the world breathed; as from the aforesaid pool of blood veins issue which ramify throughout the human body, so does the ocean fill the body of the earth with innumerable veins of water. The body of the earth lacks sinews, which do not exist because sinews are made for movement, and the world being in perpetual stability no movement occurs, and there being no movement, sinews are not necessary; but in all other points they resemble each other greatly.

53.

Water is the driver of nature.

Experience the Basis of Science

54.

In explaining the action of water remember to cite experience first and then reason.

55.

Do not forget that you must put forward propositions adducing the above-mentioned facts as illustrations, not as propositions, — that would be too simple.

56.

Water in itself has no stability and cannot move of its own accord, save to descend. Water of its own accord does not cease to move unless it is shut in.

57.

The body of the earth, like the body of animals, is intersected with ramifying veins, which are all united and constructed for the nourishment and life of the earth and of its creatures.

Water is the Blood of the World

58.

The water which rises in the mountains is the blood which keeps the mountain alive, and through this conduit or vein, nature, the helper of her creatures, prompt in the desire to repair the loss of the moisture expended, proffers the desired aid abundantly; just as in a stricken spot in man you will see, owing to the aid which is brought, the blood abound under the skin in a swelling, so as to succour the spot which has been stricken; likewise, in the case of the vine, when it is cut at its extremity, nature causes its moisture to rise from the lowest root to the end of the extremity which has been cut, and when this moisture has been expended nature ceases not to supply it with vital moisture to the end of its life.

59.

Water is that which is given to supply vital moisture to this arid earth; and the cause which propels it through its ramifications against the natural course of weighty matter is the same which stirs the humours in every kind of animal body.

Water on Mountains

60.

Water, the vital moisture of the earthly machine, moves by reason of its natural heat.

On the Water of Rivers

61.

Rivers, with their ruinous inundations, seem to me the most potent of all causes of terrestrial losses, and not fire, as some have maintained; because the violence of fire is exhausted where there is nothing forthcoming to feed it. The flowing of water, which is maintained by sloping valleys, ends and dies at the lowest depth of the valley; but fire is caused by fuel and the movement of water by incline. The fuel of fire is disunited, and its damage is disunited and isolated, and fire dies where there is no fuel. The incline of valleys is united, and damage caused by water is collective, along with the ruinous course of the river, until with its valley it winds into the sea, the universal base and sole haven of the wandering waters of rivers. But what voice or words shall I find to express the disastrous ravages, the incredible upheavals, the insatiable rapacity, caused by the headstrong rivers? What can I say? Certainly I do not feel myself equal to such a demonstration, yet by experience I will try to relate the process of ruin of the rivers which destroy their banks and against which no mortal bastion can prevail.

62.

The recesses of the bottom of the sea are perennial, the summits of mountains are transitory, whence it follows that the earth will become spherical and covered with waters, and will be uninhabitable.

Transformations in Past and Future

63.

The shores of the sea continually increase in soil, towards the middle of the sea; the cliffs and promontories of the sea are continually being ruined and consumed; the mediterranean seas will dry up and all that will remain will be the channel of the greatest river which enters into them; this will flow to the ocean and pour out its waters together with that of all the rivers which are its tributaries.

On the Earth's Vibration

64.

The subterranean courses of water, like those which are made between the air and the earth, are those which continually consume and deepen the beds of their currents. The earth which is carried by rivers is discharged at the end of their course, that is to say, the earth carried from the highest part of the river's course is discharged at the lowest depth of its course. Where fresh water arises in the sea, the miracle of the creation of an island is manifest, which will be discovered sooner or later in proportion as the quantity of water is greater or less. And an island of this kind is formed by the deposit of earth and stones made by the subterranean current of water in the channels through which it passes.

Nature's Law

65.

Nature never breaks her laws.

66.

Nature is constrained by the cause of her laws which dwells inborn in her.

67.

Without reason no effect is produced in nature; understand the reason and you will not need experience.

Cause discovered by Effect

68.

Before I proceed further I will make some experiments, because it is my intention to cite the experiment first and then to demonstrate by reasoning how such an experiment must necessarily take effect in such a manner. And this is the true rule by which investigations of natural phenomena must proceed; and although nature herself begins from the reason and ends in the result, we must pursue the contrary course and begin, as I said above, from experience and by it seek out the reason.

Repetition of Experiment

69.

Before deducing a general rule from this case repeat the experiment two or three times and see if the same results are produced.

Example of preceding Rule

70.

It several bodies of equal weight and shape are dropped one after another at equal intervals of time, the distances between each successive body will be equally increased.

The experiment to prove the above-mentioned theorem respecting motion must be made thus: Take two balls of equal weight and shape and let them fall from a great height so that when they start falling they touch one another, and let the investigator stand on the ground and watch whether the contact is maintained during their fall. This experiment must be repeated several times, so that the trial may not be marred by any accident and the experiment vitiated and the spectator deceived.

Necessity of Analysis

71.

We know definitely that sight is infinitely swift and in an instant of time perceives countless shapes, nevertheless it only sees one object at a time. Let us take an example. You, O reader, will see the whole of this written page at a glance, and you will instantly realize that it is full of various letters, but you will not realize at that moment what these letters are nor what they signify; wherefore you will have to proceed word by word and line by line to take cognizance of these letters. Again, if you wish to reach the summit of a building you must mount step by step, otherwise it will be impossible for you to reach the summit. And therefore I say to you whom nature has drawn to this art, if you wish to attain to a thorough knowledge of the forms of objects, you will begin by studying the details, and not proceed to the second until you have committed the first to memory and mastered it in practice, and if you do otherwise you will be wasting your time and protracting your studies. And remember first of all to acquire diligence, which signifies speed.

Vision

72.

Of the nature of the eye. Here are the forms, here the colours, here the form of every part of the universe are concentrated in a point, and that point is so great a marvel! O marvellous and stupendous necessity! thou dost compel by thy law,

and by the most direct path, every effect to proceed from its cause. These things are verily miracles! I wrote in my Anatomy how in so small a space the visual faculty can be reproduced and formed again in its whole expanse.

73.

In many cases one and the same thing is attracted by two violent forces, — necessity and power. The water falls in rain and by necessity the earth absorbs the humidity; the sun causes it to evaporate, not of necessity, but by power.

Unconscious Reasoning

74.

The pupil of the eye in the air expands and contracts according to every degree of motion made by the sun. And with every dilation or contraction the same object will appear of a different size, although frequently the relative scale of surrounding circumstances does not allow us to perceive these variations in any single object we look at.

The Eye

75.

The pupil of the eye dilates and contracts in proportion to the variety of bright and dark objects which are reflected in it. In this case nature has afforded compensation to the visual faculty by contracting the pupil of the eye when it is offended by excess of light and by causing it to dilate when offended by excess of darkness, like the opening of the purse. And nature here behaves like the man who has too much light in his house and closes half the window, or more or less of it according to need; and when night comes he opens the window altogether so as to see better inside his house, and nature here adopts a continued process of compensation, by continually regulating and readjusting the expansion and contracting of the pupil, in proportion to the aforesaid obscurity and light which are continually reflected in it.

Water surrounding the Globe Spherical

76.

When you collect facts relating to the science of the motion of water, remember to place under every proposition the uses to which it may be applied, in order that this knowledge may not be fruitless.

77.

This is a difficult question to answer, but I will nevertheless state my opinion. Water, which is clothed with air, desires naturally to cleave to its sphere because in this position it is without gravity. This gravity is twofold, — the gravity of the whole which tends to the centre of the elements, and the gravity which tends to the centre of the waters of the spherical orb; if this were not so the water would form a half sphere only, which is the sphere described from the centre upwards. But I see no means in the human mind of acquiring knowledge with regard to this. We must say, as we say of the magnet which attracts iron, that such a virtue is an occult property of which there is an infinite quantity in nature.

78.

In the motion of earth against earth the repercussion of the portion struck is slight.

Water struck by water, eddies in circles around the spot where the shock has taken place.

The reverberation of the voice continues for a great distance through the air; for a greater distance through fire. The mind travels for a still greater distance through the universe; but since it is finite it does not penetrate into infinity.

79.

If the water which rises on the summits of the mountains comes from the sea, whence it is propelled by its weight to a greater height than that of the mountains, why has this portion of the element of water the power to elevate itself to such an altitude and to penetrate the earth by so great an expenditure of labour and time, when the residue of the element of water, whose only obstacle is the air which does not impede it, is not able to raise itself to a similar altitude? And thou who didst devise this theory, go and study nature, so that thou mayst cease to acquire such opinions of which thou hast made so great a collection, together with the capital and interest which thou dost possess.

On the Law of Gravity

80.

The sphere of the earth has gravity which increases in proportion to the lightness of the element which contains it.

Fire is light in its sphere and its lightness increases in proportion to the weight of the element which contains it.

No primary element has gravity or lightness in its own sphere.

81.

The motion made by bodies which possess gravity to the common centre is not produced by the tendency of the body to find this centre, nor is it caused by attraction made by the centre, as by a magnet, drawing the weight towards it.

82.

Why does not the weight remain in its place?

It does not remain because it has no resistance.

And whither will it tend?

It will tend to the centre of the earth.

And why not along other lines?

Because the weight which meets with no resistance will descend by the shortest way to the lowest depth, and the lowest depth is the centre of the earth.
And how does a weight find the centre of the earth with such directness?
Because it does not proceed at random, wandering by diverse courses.

Phenomena governed by Mechanical Laws

83.

Instrumental science, that is to say, mechanics, is the most noble and most useful of sciences, inasmuch as by means of it all living bodies which have movement act; and this movement has its origin in the centre of gravity which is placed in the middle, dividing unequal weights, and it has dearth and wealth of muscles and lever also and counter-lever.

84.

Since these things are far more ancient than letters, it is no wonder if in our day no records exist to tell how these seas filled so many countries. But if some record had existed, conflagrations, floods, wars, changes of tongues and laws have consumed all that is ancient; sufficient for us is the testimony of objects born in the salt waters and found again in the high mountains far off from the seas of those times.

Heat the Vital Principle

85.

Heat causes moisture to move, and cold arrests it; as is seen in a cold country which arrests the motion of the clouds in the air. Where there is life there is heat, where there is vital heat there is movement of moisture.

Against those desiring to correct Nature

86.

The act of cutting out the nostrils of a horse is a piece of ludicrous folly. And the foolish indulge in this practice as though they considered nature had failed to supply necessary wants, and man had therefore to supplement her work. Nature made two apertures in the nose, which each in itself is half as large as the lung pipe whence breath proceeds, and if these apertures did not exist the mouth would abundantly suffice for breathing purposes. And if you said to me, Why has nature thus provided animals with nostrils if respiration through the mouth is sufficient? — I would answer that nostrils are made to be used when the mouth is employed in masticating its food.

Of Trees

87.

If a tree has been stripped of its bark in some spot, nature makes provision for this and gives a greater supply of nourishing sap to the stripped portion than to any other, so that in place of what has been taken away the bark grows thicker than in any other spot. And so impetuous is the motion of the sap that when it reaches the spot which is to be healed, it rises higher like a bounding ball, in bubbles, not unlike boiling water.

The Leaves of Plants

88.

Nature has so placed the leaves of the latest shoots of many trees that the sixth leaf is always above the first, and thus in continued succession unless the rule is obstructed. And this she has done for two useful purposes in the plant: firstly, since the branches and the fruit of the following year spring from the bud or eye which is above and in contact with the juncture of the leaves, the water which feeds the shoot may be able to run down and nourish the bud, through the drop being caught in the hollow whence the leaf springs. And the second advantage is that as these buds shoot in the following year, one will not be covered by the other, since the five shoots spring on five different sides.

From Known to Unknown

89.

In order to arrive at knowledge of the motions of birds in the air, it is first necessary to acquire knowledge of the winds, which we will prove by the motions of water in itself, and this knowledge will be a step enabling us to arrive at the knowledge of beings that fly between the air and the wind.

On the Flight of Birds

90.

The reason of this is that small birds being without down cannot support the intense cold of the high altitudes in which the vultures and eagles or and other great birds, well supplied with down and clothed with many kinds of feathers, [fly]. Again, the small birds, having delicate and thin wings, support themselves in the low air, which is denser, and they could not bear up in the rarer air, which affords slighter resistance.

On the Structure of Wings

91.

The shafts formed in the shoulders of the wings of birds have been so devised by ingenious nature as to occasion a convenient pliancy in the direct impetus which often occurs in the swift flight of birds, since she found it more practical to bend a small part of the wing in the direct flight than the whole of it.

On a Fossil Fish

92.

O time! swift devourer of all created things! How many kings, how many nations, thou hast overthrown, how great changes of kingdoms and diverse vicissitudes have succeeded one another, since the marvellous body of this fish, which perished in the caverns and intricate recesses [of the mountain]. Now

undone by time, thou liest patient in this confined spot; with thy fleshless and bare bones thou hast built the framework and the support of the mountain that is above thee.

We live by Others' Death

93.

Unconscious life remains in what is dead, which when reunited to the stomach of living men, reacquires sentient and conscious life.

Against Doctors

94.

Men are chosen to be physicians in order to minister to diseases of which they are ignorant.

95.

Every man wishes to amass money in order to give it to the physicians who are the destroyers of life; they ought therefore to be rich.

96.

Take pains to preserve thy health; and thou wilt all the more easily do this if thou avoidest physicians, because their drugs are a kind of alchemy, and there are as many books on this subject as there are on medicine.

97.

Oh! meditators on perpetual motion, how many vain projects of similar character you have devised! Go and join the seekers of gold.

Against the Seekers of Perpetual Motion

98.

The water which flows in a river moves either because it is summoned or driven, or because it moves of its own accord. If it is summoned, — and I mean sought after, — who is the seeker? If it is driven, who is the driver? If it moves of its own accord, it gives evidence of reasoning; and reasoning in bodies which continually change their shape is impossible, because in such bodies there is no consciousness.

Against Occult Sciences

99.

I wish to work miracles. I may have less than other and less energetic men; and those who wish to grow rich in a day live a long time in great poverty, as happens, and will always happen, to alchemists, who seek to make gold and silver, and to the engineers who wish from still water to obtain life and perpetual motion, and to the supreme fool, — the necromancer and the magician.

Of Astrology

100.

There is no part of astronomy which does not depend on the visual lines and on perspective, the daughter of painting; because the painter is he who by the necessity of his art has begotten perspective, and it is impossible to do without lines which include all the various figures of the bodies begotten by nature and without which the art of geometry is blind. And while the geometrist reduces every surface surrounded by lines to a square, and each body to the figure of the cube, and mathematics do the same with their cube roots and square roots, these two sciences deal only with the continuous and discontinuous quantity, but they

do not deal with the quality which constitutes the beauty of the works of nature and the ornament of the world.

101.

Here the adversary will say that he does not want so much knowledge, and the mere skill of depicting nature will suffice him. To which I make reply that there is no greater error than to trust to our judgement without other reasoning, as experience, the enemy of alchemists, necromancers and other foolish intellects, has in all times proved.

Against Alchemists

102.

The lying interpreters of nature affirm that quicksilver is the common seed of all metals. They do not bear in mind that nature raises substances according to the diversity of things which she wishes to produce in the world.

Against Necromancy

103.

The belief in necromancy is reputed to be the most foolish of all human opinions. It is the sister of alchemy which gives birth to simple and natural things; but it is all the more reprehensible than alchemy, inasmuch as it brings forth nothing but what is like itself, that is, lies. This is not the case with alchemy, which is confined to the simple products of nature, and whose function cannot be performed by nature herself, because in it there are no organic instruments with which it can work, such as the hands are to man and which have enabled him to make glass, &c. But necromancy, the flag and flying banner, blown hither and thither by the winds, is the guide of the silly multitude, which constantly bears witness with gaping wonder to the countless effects of this art; and whole books are written which declare that incantations and spirits are efficacious and speak without tongues and without vocal organs, without

which it is impossible to speak, and carry the heaviest weights, raising tempests and rain and transforming men into cats, wolves and other beasts, although they who affirm such things are the first to be transformed into beasts. And certainly if such necromancy existed, as is believed by lower intellects, there is nothing on the earth which would be so effectual both as regards the service and detriment of man; because if it is true that this art has the power to disturb the calm serenity of the atmosphere, changing it into night and producing sparks and winds, with fearful thunder and lightnings that fly through the darkness, and overthrowing high buildings with violent winds and uprooting forests and striking armies and shattering and overwhelming them, and producing, in addition to this, devastating storms which rob the peasants of the fruits of their toil, what kind of warfare is there so deadly to the enemy? Who in naval warfare can be compared with him who commands the winds and generates storms which ruin and sink any fleet whatsoever? Certainly he who could dispose of such violent forces would be the lord of nations, and no human skill could resist his deadly power. The hidden treasures and gems concealed in the body of the earth would be manifest unto him. He would let himself be borne through the air from the east to the west, and through all the opposed regions of the universe. But why should I proceed further? What thing is there which could not be effected by such an art? Nothing, save the discovery of immortality. And if it is true, why has it not remained among men who so greatly desired it, and led them to disregard any deity? And I know that there are many who to satisfy a whim would destroy God and the universe. And if necromancy has not remained with man in spite of its being so necessary to him it can never have existed, nor will it ever exist according to the definition of the spirit which is invisible in the body, for in the elements there are no incorporate things, for where there is no body there is a vacuum, and a vacuum cannot exist in the elements because it would be immediately filled by them.

Deceptiveness of the Senses

104.

The eye in its given distances and by its given means deceives itself in the performance of its functions less than any other sense, because it sees in straight lines which form a cone, the base of which is the object it perceives, and transmits it to the eye, as I intend to prove. But the ear greatly deceives itself as to the position and distance of the objects it apprehends, because the sonorous

waves do not reach it in straight lines, like those of the eye, but by tortuous and reflex lines, and often the most remote seem to be nearest, owing to the peregrinations of such waves, although the voice of the echo is transmitted to the sense by straight lines only. The smell is less certain of the spot whence the odour arises, but taste and touch alone come into direct contact with the object which they apprehend.

On the Conception of Nothingness

105.

The smallest natural point is larger than all mathematical points, and the proof of this is that the natural point has continuity, and everything which has continuity is infinitely divisible; but the mathematical point is indivisible because it is not a quantity. Every continuous quantity is mentally infinitely divisible. Among the magnitude of things which are among us, the chief of all is nothingness; and its function extends to matter that does not exist, and its essence is in time in the past or in the future, and it has nothing of the present. This nothingness has its part equal to the whole and the whole to the part, and the divisible to the indivisible, and produces the same result by addition or subtraction, or if it be divided or multiplied, — as is proved by arithmeticians by their tenth character, which represents nothing. And its power does not extend to the things of nature.

That which is called nothingness is found only in time and in words: in time it is found in the past and future, and not in the present; and thus in words among things which are said to be nonexistent or impossible. In time nothingness dwells in the past and the future, and not at all in the present, and in nature it resides among the things which are impossible. Whence from that which has been said, it has no being, because where there is nothingness there would be a vacuum.

On Spirits

106.

With regard to this matter, we have said on the previous page that the definition of a spirit is a power united with a body, because it cannot move of its own accord nor acquire any kind of motion. And if you say that it moves itself,

this cannot be within the elements, because if the spirit is an incorporate quantity this quantity is a vacuum and the vacuum does not exist in nature, and if it did exist it would be immediately filled by the rushing in of the element in which the vacuum was formed. So according to the definition of weight which runs: "Gravity is an accidental power created by one element attracted to or suspended in another," it follows that no element, weighing nothing in its own element, can have weight in the element which is above it and lighter than it; for instance, no one part of water has no more gravity or lightness than any other part, but if you were to draw it up into the air, it would acquire weight, and this weight cannot sustain itself by itself; and it must therefore inevitably fall, and thus wherever there is a vacuum in water it will fall in. The same thing would happen with a spirit among the elements where it would continuously generate a vacuum in whatever element it might find itself, for which reason it is inevitable that it would move in a constant flight to the sky until it had quitted these elements.

Has the Spirit a Body?

107.

We have proved that a spirit cannot exist in the elements without a body, nor move of itself by voluntary motion unless it be to rise upwards. But now we will say that if such a spirit took a body made of air it would inevitably melt into air, because if it remained united it would be separated and fall and form a vacuum, as we have described above. Therefore if it desired to remain in the air it is necessary that it should blend with a quantity of air, and if it were united with the air, two difficulties arise: that is, that it will rarefy that portion of air with which it is mingled, and this rarefied air will fly upwards and will not remain in the air which is heavier than itself; and besides this the ethereal spiritual essence is disunited, and its nature is changed, for which reason that nature loses some of its first virtue. There is in addition to these a third difficulty, and this is that a body of this kind, made of air and assumed by the spirits, is exposed to the penetrating winds which continually sunder and scatter the united portions of the air, eddying and whirling amidst the rest of the atmosphere; therefore the spirit who would pervade this air would be dismembered or rent and broken up with the rending of the air of which it formed part.

108.

It is impossible that the spirit, incorporated with a certain quantity of air, should move this air; and this is proved by the passage where it is said that “the spirit rarefies that portion of the air with which it is mingled.” This air therefore will rise high above the other air, and the air will be set in motion by its own lightness and not by the volition of the spirit, and if this air encounters a wind, the air will be moved by the wind and not by the spirit which is incorporated in it.

Can the Spirit speak?

109.

In order to show whether the spirit can speak or not it is first necessary to define the voice and the manner of its origin. The following will be our definition: The voice is the movement of air in friction against a dense body, or a dense body in friction against the air (which is the same idea), and by this friction of the dense and the rare what is rare is condensed, and resistance is caused; and again, when the rare in swift motion and the rare in slow motion come into contact, they condense one another and produce sound, and a great noise is made. The sound or murmur made by the rare moving through the rare with slow motion is like the great flame whence sounds issue in the air; the exceedingly great noise made by the rare, when the air which is rare and swift mingles with that which is rare and in [slow] motion, is like the flame of fire issuing from a great gun and striking against the air; likewise the flame when it issues from a cloud strikes the air as it begets the thunderbolt. Therefore we will say that the spirit cannot produce a voice unless the air be set in motion, but since there is no air within, it cannot discharge what it does not possess; and if it wishes to move that air in which it is incorporated, it is necessary that the spirit should multiply itself; but that which has no quantity cannot be multiplied. In the fourth place it is said, that no rare body can move if it has not a stable spot whence it may take its motion, and more especially is this the case when an element must move in its own element, which does not move of itself, excepting by uniform evaporation at the centre of the thing evaporated; as occurs in the case of the sponge squeezed in the hand under water, whence the water escapes in every direction with equal motion through the spaces between the fingers of

the hand which squeezes it. As to whether the spirit has an articulate voice and can be heard, and as to what are hearing and sight — the wave of the voice travels through the air as the images of objects travel to the eye.

110.

O mathematicians, clear up this error! The spirit cannot have a voice, for where there is a voice there is a body, and where there is a body there is occupation of space, which prevents the eye seeing what is behind that space; therefore a body fills all the surrounding air, that is to say, with its own image.

111.

There can be no voice where there is no motion or percussion of the air, there can be no percussion of the air where there is no instrument, there can be no such thing as an immaterial instrument; and this being so, a spirit can have neither voice, nor shape, nor force; and if it assumes a shape it can neither penetrate nor enter where the issues are closed. If any one were to say that a spirit may take bodies of various shapes by means of concentrated and compressed air, and by means of this instrument speak and move with force — I reply to this argument that where there are no nerves or bones, no force can be expended in any movement made by these imaginary spirits.

The Criticism

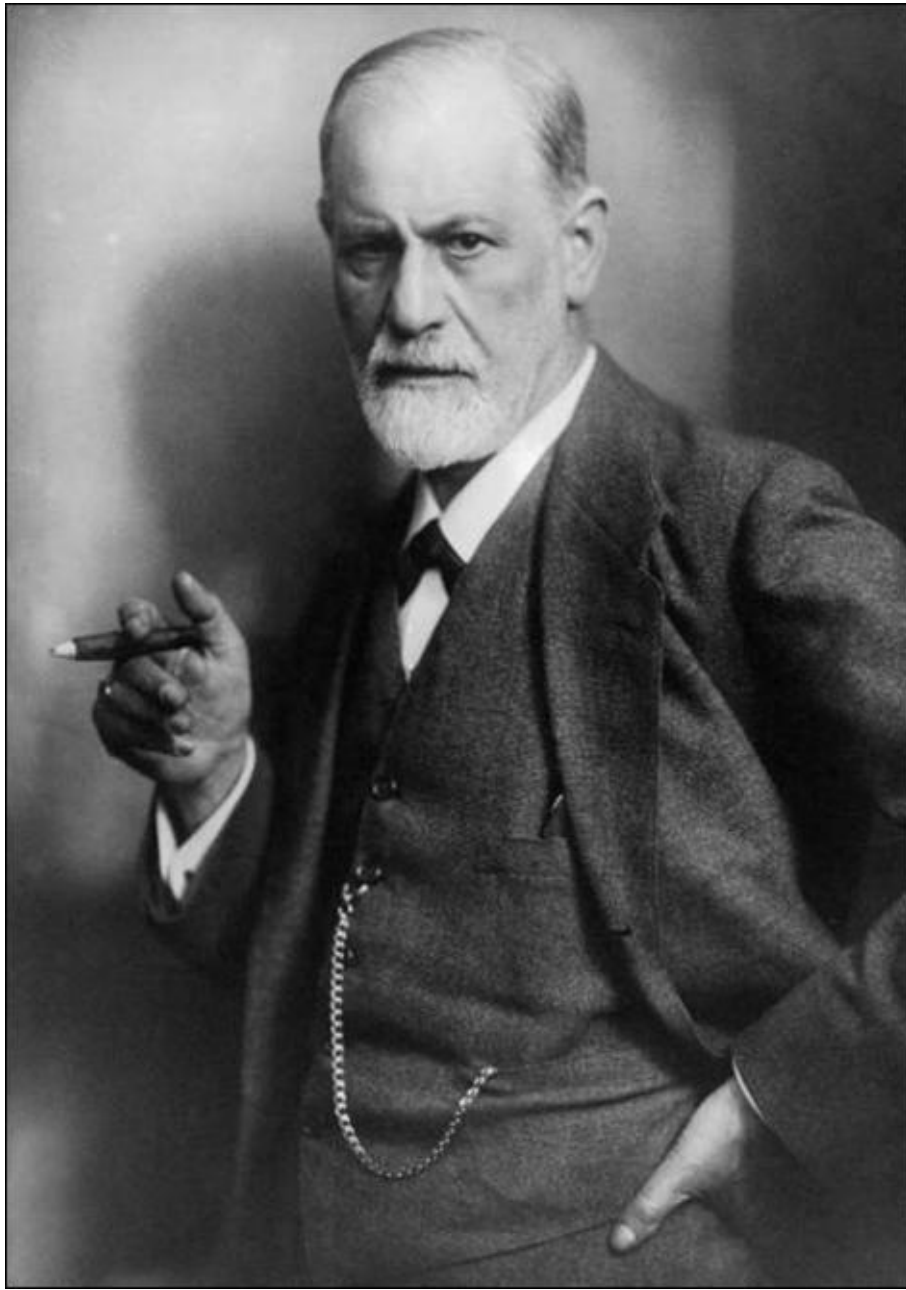


Clos Lucé in France, where Leonardo died in 1519

LEONARDO DA VINCI by Sigmund Freud



Sigmund Freud (1856-1939), the renowned Austrian neurologist, who founded the discipline of psychoanalysis, published this study of Leonardo and his works in 1916.



Sigmund Freud, 1921

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I

WHEN psychoanalytic investigation, which usually contents itself with frail human material, approaches the great personages of humanity, it is not impelled to it by motives which are often attributed to it by laymen. It does not strive “to blacken the radiant and to drag the sublime into the mire”; it finds no satisfaction in diminishing the distance between the perfection of the great and the inadequacy of the ordinary objects. But it cannot help finding that everything is worthy of understanding that can be perceived through those prototypes, and it also believes that none is so big as to be ashamed of being subject to the laws which control the normal and morbid actions with the same strictness.

Leonardo da Vinci (1452-1519) was admired even by his contemporaries as one of the greatest men of the Italian Renaissance, still even then he appeared as mysterious to them as he now appears to us. An all-sided genius, “whose form can only be divined but never deeply fathomed,” he exerted the most decisive influence on his time as an artist; and it remained to us to recognize his greatness as a naturalist which was united in him with the artist. Although he left masterpieces of the art of painting, while his scientific discoveries remained unpublished and unused, the investigator in him has never quite left the artist, often it has severely injured the artist and in the end it has perhaps suppressed the artist altogether. According to Vasari, Leonardo reproached himself during the last hour of his life for having insulted God and men because he has not done his duty to his art. And even if Vasari’s story lacks all probability and belongs to those legends which began to be woven about the mystic master while he was still living, it nevertheless retains indisputable value as a testimonial of the judgment of those people and of those times.

What was it that removed the personality of Leonardo from the understanding of his contemporaries? Certainly not the many sidedness of his capacities and knowledge, which allowed him to install himself as a player of the lyre on an instrument invented by himself, in the court of Lodovico Sforza, nicknamed Il Moro, the Duke of Milan, or which allowed him to write to the same person that remarkable letter in which he boasts of his abilities as a civil and military engineer. For the combination of manifold talents in the same person was not unusual in the times of the Renaissance; to be sure Leonardo himself furnished one of the most splendid examples of such persons. Nor did he belong to that type of genial persons who are outwardly poorly endowed by nature, and who on

their side place no value on the outer forms of life, and in the painful gloominess of their feelings fly from human relations. On the contrary he was tall and symmetrically built, of consummate beauty of countenance and of unusual physical strength, he was charming in his manner, a master of speech, and jovial and affectionate to everybody. He loved beauty in the objects of his surroundings, he was fond of wearing magnificent garments and appreciated every refinement of conduct. In his treatise on the art of painting he compares in a significant passage the art of painting with its sister arts and thus discusses the difficulties of the sculptor: "Now his face is entirely smeared and powdered with marble dust, so that he looks like a baker, he is covered with small marble splinters, so that it seems as if it snowed on his back, and his house is full of stone splinters, and dust. The case of the painter is quite different from that; for the painter is well dressed and sits with great comfort before his work, he gently and very lightly brushes in the beautiful colors. He wears as decorative clothes as he likes, and his house is filled with beautiful paintings and is spotlessly clean. He often enjoys company, music, or some one may read for him various nice works, and all this can be listened to with great pleasure, undisturbed by any pounding from the hammer and other noises."

It is quite possible that the conception of a beaming jovial and happy Leonardo was true only for the first and longer period of the master's life. From now on, when the downfall of the rule of Lodovico Moro forced him to leave Milan, his sphere of action and his assured position, to lead an unsteady and unsuccessful life until his last asylum in France, it is possible that the luster of his disposition became pale and some odd features of his character became more prominent. The turning of his interest from his art to science which increased with age must have also been responsible for widening the gap between himself and his contemporaries. All his efforts with which, according to their opinion, he wasted his time instead of diligently filling orders and becoming rich as perhaps his former classmate Perugino, seemed to his contemporaries as capricious playing, or even caused them to suspect him of being in the service of the "black art." We who know him from his sketches understand him better. In a time in which the authority of the church began to be substituted by that of antiquity and in which only theoretical investigation existed, he the forerunner, or better the worthy competitor of Bacon and Copernicus, was necessarily isolated. When he dissected cadavers of horses and human beings, and built flying apparatus, or when he studied the nourishment of plants and their behavior towards poisons, he naturally deviated much from the commentators of Aristotle and came nearer the despised alchemists, in whose laboratories the experimental investigations found some refuge during these unfavorable times.

The effect that this had on his paintings was that he disliked to handle the brush, he painted less and what was more often the case, the things he began were mostly left unfinished; he cared less and less for the future fate of his works. It was this mode of working that was held up to him as a reproach from his contemporaries to whom his behavior to his art remained a riddle.

Many of Leonardo's later admirers have attempted to wipe off the stain of unsteadiness from his character. They maintained that what is blamed in Leonardo is a general characteristic of great artists. They said that even the energetic Michelangelo who was absorbed in his work left many incompleted works, which was as little due to his fault as to Leonardo's in the same case. Besides some pictures were not as unfinished as he claimed, and what the layman would call a masterpiece may still appear to the creator of the work of art as an unsatisfied embodiment of his intentions; he has a faint notion of a perfection which he despairs of reproducing in likeness. Least of all should the artist be held responsible for the fate which befalls his works.

As plausible as some of these excuses may sound they nevertheless do not explain the whole state of affairs which we find in Leonardo. The painful struggle with the work, the final flight from it and the indifference to its future fate may be seen in many other artists, but this behavior is shown in Leonardo to highest degree. Edm. Solmi_cites (p. 12) the expression of one of his pupils: "Pareva, che ad ogni ora tremasse, quando si poneva a dipingere, e però no diede mai fine ad alcuna cosa cominciata, considerando la grandezza dell'arte, tal che egli scorgeva errori in quelle cose, che ad altri parevano miracoli." His last pictures, Leda, the Madonna di Saint Onofrio, Bacchus and St. John the Baptist, remained unfinished "come quasi intervenne di tutte le cose sue." Lomazzo, who finished a copy of The Holy Supper, refers in a sonnet to the familiar inability of Leonardo to finish his works:

"Protogen che il penel di sue pitture
Non levava, agguaglio il Vinci Divo,
Di cui opra non è finita pure."

The slowness with which Leonardo worked was proverbial. After the most thorough preliminary studies he painted The Holy Supper for three years in the cloister of Santa Maria delle Grazie in Milan. One of his contemporaries, Matteo Bandelli, the writer of novels, who was then a young monk in the cloister, relates that Leonardo often ascended the scaffold very early in the morning and did not leave the brush out of his hand until twilight, never thinking of eating or drinking. Then days passed without putting his hand on it, sometimes he remained for hours before the painting and derived satisfaction from studying it

by himself. At other times he came directly to the cloister from the palace of the Milanese Castle where he formed the model of the equestrian statue for Francesco Sforza, in order to add a few strokes with the brush to one of the figures and then stopped immediately. According to Vasari he worked for years on the portrait of Monna Lisa, the wife of the Florentine de Gioconda, without being able to bring it to completion. This circumstance may also account for the fact that it was never delivered to the one who ordered it but remained with Leonardo who took it with him to France. Having been procured by King Francis I, it now forms one of the greatest treasures of the Louvre.

When one compares these reports about Leonardo's way of working with the evidence of the extraordinary amount of sketches and studies left by him, one is bound altogether to reject the idea that traits of flightiness and unsteadiness exerted the slightest influence on Leonardo's relation to his art. On the contrary one notices a very extraordinary absorption in work, a richness in possibilities in which a decision could be reached only hesitatingly, claims which could hardly be satisfied, and an inhibition in the execution which could not even be explained by the inevitable backwardness of the artist behind his ideal purpose. The slowness which was striking in Leonardo's works from the very beginning proved to be a symptom of his inhibition, a forerunner of his turning away from painting which manifested itself later. It was this slowness which decided the not undeserving fate of The Holy Supper. Leonardo could not take kindly to the art of fresco painting which demands quick work while the background is still moist, it was for this reason that he chose oil colors, the drying of which permitted him to complete the picture according to his mood and leisure. But these colors separated themselves from the background upon which they were painted and which isolated them from the brick wall; the blemishes of this wall and the vicissitudes to which the room was subjected seemingly contributed to the inevitable deterioration of the picture.

The picture of the cavalry battle of Anghiari, which in competition with Michelangelo he began to paint later on a wall of the Sala de Consiglio in Florence and which he also left in an unfinished state, seemed to have perished through the failure of a similar technical process. It seems here as if a peculiar interest, that of the experimenter, at first reinforced the artistic, only later to damage the art production.

The character of the man Leonardo evinces still some other unusual traits and apparent contradictions. Thus a certain inactivity and indifference seemed very evident in him. At a time when every individual sought to gain the widest latitude for his activity, which could not take place without the development of energetic aggression towards others, he surprised every one through his quiet

peacefulness, his shunning of all competition and controversies. He was mild and kind to all, he was said to have rejected a meat diet because he did not consider it just to rob animals of their lives, and one of his special pleasures was to buy caged birds in the market and set them free. He condemned war and bloodshed and designated man not so much as the king of the animal world, but rather as the worst of the wild beasts. But this effeminate delicacy of feeling did not prevent him from accompanying condemned criminals on their way to execution in order to study and sketch in his notebook their features, distorted by fear, nor did it prevent him from inventing the most cruel offensive weapons, and from entering the service of Cesare Borgia as chief military engineer. Often he seemed to be indifferent to good and evil, or he had to be measured with a special standard. He held a high position in Cesare's campaign which gained for this most inconsiderate and most faithless of foes the possession of the Romagna. Not a single line of Leonardo's sketches betrays any criticism or sympathy of the events of those days. The comparison with Goethe during the French campaign cannot here be altogether rejected.

If a biographical effort really endeavors to penetrate the understanding of the psychic life of its hero it must not, as happens in most biographies through discretion or prudery, pass over in silence the sexual activity or the sex peculiarity of the one examined. What we know about it in Leonardo is very little but full of significance. In a period where there was a constant struggle between riotous licentiousness and gloomy asceticism, Leonardo presented an example of cool sexual rejection which one would not expect in an artist and a portrayer of feminine beauty. Solmi cites the following sentence from Leonardo showing his frigidity: "The act of procreation and everything that has any relation to it is so disgusting that human beings would soon die out if it were not a traditional custom and if there were no pretty faces and sensuous dispositions." His posthumous works which not only treat of the greatest scientific problems but also comprise the most guileless objects which to us do not seem worthy of so great a mind (an allegorical natural history, animal fables, witticisms, prophecies), are chaste to a degree — one might say abstinent — that in a work of *belle lettres* would excite wonder even to-day. They evade everything sexual so thoroughly, as if Eros alone who preserves everything living was no worthy material for the scientific impulse of the investigator. It is known how frequently great artists found pleasure in giving vent to their phantasies in erotic and even grossly obscene representations; in contradistinction to this Leonardo left only some anatomical drawings of the woman's internal genitals, the position of the child in the womb, etc.

It is doubtful whether Leonardo ever embraced a woman in love, nor is it

known that he ever entertained an intimate spiritual relation with a woman as in the case of Michelangelo and Vittoria Colonna. While he still lived as an apprentice in the house of his master Verrocchio, he with other young men were accused of forbidden homosexual relations which ended in his acquittal. It seems that he came into this suspicion because he employed as a model a boy of evil repute. When he was a master he surrounded himself with handsome boys and youths whom he took as pupils. The last of these pupils Francesco Melzi, accompanied him to France, remained with him until his death, and was named by him as his heir. Without sharing the certainty of his modern biographers, who naturally reject the possibility of a sexual relation between himself and his pupils as a baseless insult to this great man, it may be thought by far more probable that the affectionate relationships of Leonardo to the young men did not result in sexual activity. Nor should one attribute to him a high measure of sexual activity.

The peculiarity of this emotional and sexual life viewed in connection with Leonardo's double nature as an artist and investigator can be grasped only in one way. Of the biographers to whom psychological viewpoints are often very foreign, only one, Edm. Solmi, has to my knowledge approached the solution of the riddle. But a writer, Dimitri Sergewitsch Merejkowski, who selected Leonardo as the hero of a great historical novel has based his delineation on such an understanding of this unusual man, and if not in dry words he gave unmistakable utterance in plastic expression in the manner of a poet. Solmi judges Leonardo as follows: "But the unrequited desire to understand everything surrounding him, and with cold reflection to discover the deepest secret of everything that is perfect, has condemned Leonardo's works to remain forever unfinished." In an essay of the Conferenze Fiorentine the utterances of Leonardo are cited, which show his confession of faith and furnish the key to his character.

*"Nessuna cosa si può amare nè odiare, se
prima no si ha cognition di quella."*

That is: One has no right to love or to hate anything if one has not acquired a thorough knowledge of its nature. And the same is repeated by Leonardo in a passage of the Treatise on the Art of Painting where he seems to defend himself against the accusation of irreligiousness:

"But such censurers might better remain silent. For that action is the manner of showing the workmaster so many wonderful things, and this is the way to love so great a discoverer. For, verily great love springs from great knowledge of the beloved object, and if you little know it you will be able to love it only little or not at all."

The value of these utterances of Leonardo cannot be found in that they impart to us an important psychological fact, for what they maintain is obviously false, and Leonardo must have known this as well as we do. It is not true that people refrain from loving or hating until they have studied and become familiar with the nature of the object to whom they wish to give these affects, on the contrary they love impulsively and are guided by emotional motives which have nothing to do with cognition and whose affects are weakened, if anything, by thought and reflection. Leonardo only could have implied that the love practiced by people is not of the proper and unobjectionable kind, one should so love as to hold back the affect and to subject it to mental elaboration, and only after it has stood the test of the intellect should free play be given to it. And we thereby understand that he wishes to tell us that this was the case with himself and that it would be worth the effort of everybody else to treat love and hatred as he himself does.

And it seems that in his case it was really so. His affects were controlled and subjected to the investigation impulse, he neither loved nor hated, but questioned himself whence does that arise, which he was to love or hate, and what does it signify, and thus he was at first forced to appear indifferent to good and evil, to beauty and ugliness. During this work of investigation love and hatred threw off their designs and uniformly changed into intellectual interest. As a matter of fact Leonardo was not dispassionate, he did not lack the divine spark which is the mediate or immediate motive power — *il primo motore* — of all human activity. He only transmuted his passion into inquisitiveness. He then applied himself to study with that persistence, steadiness, and profundity which comes from passion, and on the height of the psychic work, after the cognition was won, he allowed the long checked affect to break loose and to flow off freely like a branch of a stream, after it has accomplished its work. At the height of his cognition when he could examine a big part of the whole he was seized with a feeling of pathos, and in ecstatic words he praised the grandeur of that part of creation which he studied, or — in religious cloak — the greatness of the creator. Solmi has correctly divined this process of transformation in Leonardo. According to the quotation of such a passage, in which Leonardo celebrated the higher impulse of nature (“O mirabile necessita ...”) he said: “Tale trasfigurazione della scienza della natura in emozione, quasi direi, religiosa, è uno dei tratti caratteristici de manoscritti vinciani, e si trova cento e cento volte espressa....”

Leonardo was called the Italian Faust on account of his insatiable and indefatigable desire for investigation. But even if we disregard the fact that it is the possible retransformation of the desire for investigation into the joys of life

which is presupposed in the Faust tragedy, one might venture to remark that Leonardo's system recalls Spinoza's mode of thinking.

The transformation of psychic motive power into the different forms of activity is perhaps as little convertible without loss, as in the case of physical powers. Leonardo's example teaches how many other things one must follow up in these processes. Not to love before one gains full knowledge of the thing loved presupposes a delay which is harmful. When one finally reaches cognition he neither loves nor hates properly; one remains beyond love and hatred. One has investigated instead of having loved. It is perhaps for this reason that Leonardo's life was so much poorer in love than those of other great men and great artists. The storming passions of the soul-stirring and consuming kind, in which others experience the best part of their lives, seem to have missed him.

There are still other consequences when one follows Leonardo's dictum. Instead of acting and producing one just investigates. He who begins to divine the grandeur of the universe and its needs readily forgets his own insignificant self. When one is struck with admiration and becomes truly humble he easily forgets that he himself is a part of that living force, and that according to the measure of his own personality he has the right to make an effort to change that destined course of the world, the world in which the insignificant is no less wonderful and important than the great.

Solmi thinks that Leonardo's investigations started with his art, he tried to investigate the attributes and laws of light, of color, of shades and of perspective so as to be sure of becoming a master in the imitation of nature and to be able to show the way to others. It is probable that already at that time he overestimated the value of this knowledge for the artist. Following the guide-rope of the painter's need, he was then driven further and further to investigate the objects of the art of painting, such as animals and plants, and the proportions of the human body, and to follow the path from their exterior to their interior structure and biological functions, which really also express themselves in their appearance and should be depicted in art. And finally he was pulled along by this overwhelming desire until the connection was torn from the demands of his art, so that he discovered the general laws of mechanics and divined the history of the stratification and fossilization of the Arno-valley, until he could enter in his book with capital letters the cognition: *Il sole non si move* (The sun does not move). His investigations were thus extended over almost all realms of natural science, in every one of which he was a discoverer or at least a prophet or forerunner. However, his curiosity continued to be directed to the outer world, something kept him away from the investigation of the psychic life of men; there was little room for psychology in the "Accademia Vinciana," for which he drew

very artistic and very complicated emblems.

When he later made the effort to return from his investigations to the art from which he started he felt that he was disturbed by the new paths of his interest and by the changed nature of his psychic work. In the picture he was interested above all in a problem, and behind this one he saw emerging numerous other problems just as he was accustomed in the endless and indeterminable investigations of natural history. He was no longer able to limit his demands, to isolate the work of art, and to tear it out from that great connection of which he knew it formed part. After the most exhausting efforts to bring to expression all that was in him, all that was connected with it in his thoughts, he was forced to leave it unfinished, or to declare it incomplete.

The artist had once taken into his service the investigator to assist him, now the servant was stronger and suppressed his master.

When we find in the portrait of a person one single impulse very forcibly developed, as curiosity in the case of Leonardo, we look for the explanation in a special constitution, concerning its probable organic determination hardly anything is known. Our psychoanalytic studies of nervous people lead us to look for two other expectations which we would like to find verified in every case. We consider it probable that this very forcible impulse was already active in the earliest childhood of the person, and that its supreme sway was fixed by infantile impressions; and we further assume that originally it drew upon sexual motive powers for its reënforcement so that it later can take the place of a part of the sexual life. Such person would then, e.g., investigate with that passionate devotion which another would give to his love, and he could investigate instead of loving. We would venture the conclusion of a sexual reënforcement not only in the impulse to investigate, but also in most other cases of special intensity of an impulse.

Observation of daily life shows us that most persons have the capacity to direct a very tangible part of their sexual motive powers to their professional or business activities. The sexual impulse is particularly suited to yield such contributions because it is endowed with the capacity of sublimation, i.e., it has the power to exchange its nearest aim for others of higher value which are not sexual. We consider this process as proved, if the history of childhood or the psychic developmental history of a person shows that in childhood this powerful impulse was in the service of the sexual interest. We consider it a further corroboration if this is substantiated by a striking stunting in the sexual life of mature years, as if a part of the sexual activity had now been replaced by the activity of the predominant impulse.

The application of these assumptions to the case of the predominant

investigation-impulse seems to be subject to special difficulties, as one is unwilling to admit that this serious impulse exists in children or that children show any noteworthy sexual interest. However, these difficulties are easily obviated. The untiring pleasure in questioning as seen in little children demonstrates their curiosity, which is puzzling to the grown-up, as long as he does not understand that all these questions are only circumlocutions, and that they cannot come to an end because they replace only one question which the child does not put. When the child becomes older and gains more understanding this manifestation of curiosity suddenly disappears. But psychoanalytic investigation gives us a full explanation in that it teaches us that many, perhaps most children, at least the most gifted ones, go through a period beginning with the third year, which may be designated as the period of *infantile sexual investigation*. As far as we know, the curiosity is not awakened spontaneously in children of this age, but is aroused through the impression of an important experience, through the birth of a little brother or sister, or through fear of the same endangered by some outward experience, wherein the child sees a danger to his egotistic interests. The investigation directs itself to the question whence children come, as if the child were looking for means to guard against such undesired event. We were astonished to find that the child refuses to give credence to the information imparted to it, e.g., it energetically rejects the mythological and so ingenious stork-fable, we were astonished to find that its psychic independence dates from this act of disbelief, that it often feels itself at serious variance with the grown-ups, and never forgives them for having been deceived of the truth on this occasion. It investigates in its own way, it divines that the child is in the mother's womb, and guided by the feelings of its own sexuality, it formulates for itself theories about the origin of children from food, about being born through the bowels, about the rôle of the father which is difficult to fathom, and even at that time it has a vague conception of the sexual act which appears to the child as something hostile, as something violent. But as its own sexual constitution is not yet equal to the task of producing children, his investigation whence come children must also run aground and must be left in the lurch as unfinished. The impression of this failure at the first attempt of intellectual independence seems to be of a persevering and profoundly depressing nature.

If the period of infantile sexual investigation comes to an end through an impetus of energetic sexual repression, the early association with sexual interest may result in three different possibilities for the future fate of the investigation impulse. The investigation either shares the fate of the sexuality, the curiosity henceforth remains inhibited and the free activity of intelligence may become

narrowed for life; this is especially made possible by the powerful religious inhibition of thought, which is brought about shortly hereafter through education. This is the type of neurotic inhibition. We know well that the so acquired mental weakness furnishes effective support for the outbreak of a neurotic disease. In a second type the intellectual development is sufficiently strong to withstand the sexual repression pulling at it. Sometimes after the disappearance of the infantile sexual investigation, it offers its support to the old association in order to elude the sexual repression, and the suppressed sexual investigation comes back from the unconscious as compulsive reasoning, it is naturally distorted and not free, but forceful enough to sexualize even thought itself and to accentuate the intellectual operations with the pleasure and fear of the actual sexual processes. Here the investigation becomes sexual activity and often exclusively so, the feeling of settling the problem and of explaining things in the mind is put in place of sexual gratification. But the indeterminate character of the infantile investigation repeats itself also in the fact that this reasoning never ends, and that the desired intellectual feeling of the solution constantly recedes into the distance. By virtue of a special disposition the third, which is the most rare and most perfect type, escapes the inhibition of thought and the compulsive reasoning. Also here sexual repression takes place, it is unable, however, to direct a partial impulse of the sexual pleasure into the unconscious, but the libido withdraws from the fate of the repression by being sublimated from the beginning into curiosity, and by reënforcing the powerful investigation impulse. Here, too, the investigation becomes more or less compulsive and a substitute of the sexual activity, but owing to the absolute difference of the psychic process behind it (sublimation in place of the emergence from the unconscious) the character of the neurosis does not manifest itself, the subjection to the original complexes of the infantile sexual investigation disappears, and the impulse can freely put itself in the service of the intellectual interest. It takes account of the sexual repression which made it so strong in contributing to it sublimated libido, by avoiding all occupation with sexual themes.

In mentioning the concurrence in Leonardo of the powerful investigation impulse with the stunting of his sexual life which was limited to the so-called ideal homosexuality, we feel inclined to consider him as a model example of our third type. The most essential point of his character and the secret of it seems to lie in the fact, that after utilizing the infantile activity of curiosity in the service of sexual interest he was able to sublimate the greater part of his libido into the impulse of investigation. But to be sure the proof of this conception is not easy to produce. To do this we would have to have an insight into the psychic development of his first childhood years, and it seems foolish to hope for such

material when the reports concerning his life are so meager and so uncertain; and moreover, when we deal with information which even persons of our own generation withdraw from the attention of the observer.

We know very little concerning Leonardo's youth. He was born in 1452 in the little city of Vinci between Florence and Empoli; he was an illegitimate child which was surely not considered a great popular stain in that time. His father was Ser Piero da Vinci, a notary and descendant of notaries and farmers, who took their name from the place Vinci; his mother, a certain Caterina, probably a peasant girl, who later married another native of Vinci. Nothing else about his mother appears in the life history of Leonardo, only the writer Merejkowski believed to have found some traces of her. The only definite information about Leonardo's childhood is furnished by a legal document from the year 1457, a register of assessment in which Vinci Leonardo is mentioned among the members of the family as a five-year-old illegitimate child of Ser Piero. As the marriage of Ser Piero with Donna Albiera remained childless the little Leonardo could be brought up in his father's house. He did not leave this house until he entered as apprentice — it is not known what year — in the studio of Andrea del Verrocchio. In 1472 Leonardo's name could already be found in the register of the members of the "Compagnia dei Pittori." That is all.

II

As far as I know Leonardo only once interspersed in his scientific descriptions a communication from his childhood. In a passage where he speaks about the flight of the vulture, he suddenly interrupts himself in order to follow up a memory from very early years which came to his mind.

“It seems that it had been destined before that I should occupy myself so thoroughly with the vulture, for it comes to my mind as a very early memory, when I was still in the cradle, a vulture came down to me, he opened my mouth with his tail and struck me a few times with his tail against my lips.”

We have here an infantile memory and to be sure of the strangest sort. It is strange on account of its content and account of the time of life in which it was fixed. That a person could retain a memory of the nursing period is perhaps not impossible, but it can in no way be taken as certain. But what this memory of Leonardo states, namely, that a vulture opened the child's mouth with its tail, sounds so improbable, so fabulous, that another conception which puts an end to the two difficulties with one stroke appeals much more to our judgment. The scene of the vulture is not a memory of Leonardo, but a phantasy which he formed later, and transferred into his childhood. The childhood memories of persons often have no different origin, as a matter of fact, they are not fixated from an experience like the conscious memories from the time of maturity and then repeated, but they are not produced until a later period when childhood is already past, they are then changed and disguised and put in the service of later tendencies, so that in general they cannot be strictly differentiated from phantasies. Their nature will perhaps be best understood by recalling the manner in which history writing originated among ancient nations. As long as the nation was small and weak it gave no thought to the writing of its history, it tilled the soil of its land, defended its existence against its neighbors by seeking to wrest land from them and endeavored to become rich. It was a heroic but unhistoric time. Then came another age, a period of self-realization in which one felt rich and powerful, and it was then that one experienced the need to discover whence one originated and how one developed. The history-writing which then continues to register the present events throws also its backward glance to the past, it gathers traditions and legends, it interprets what survived from olden times into customs and uses, and thus creates a history of past ages. It is quite natural that this history of the past ages is more the expressions of opinions and

desires of the present than a faithful picture of the past, for many a thing escaped the people's memory, other things became distorted, some trace of the past was misunderstood and interpreted in the sense of the present; and besides one does not write history through motives of objective curiosity, but because one desires to impress his contemporaries, to stimulate and extol them, or to hold the mirror before them. The conscious memory of a person concerning the experiences of his maturity may now be fully compared to that of history writing, and his infantile memories, as far as their origin and reliability are concerned will actually correspond to the history of the primitive period of a people which was compiled later with purposive intent.

Now one may think that if Leonardo's story of the vulture which visited him in his cradle is only a phantasy of later birth, it is hardly worth while giving more time to it. One could easily explain it by his openly avowed inclination to occupy himself with the problem of the flight of the bird which would lend to this phantasy an air of predetermined fate. But with this depreciation one commits as great an injustice as if one would simply ignore the material of legends, traditions, and interpretations in the primitive history of a people. Notwithstanding all distortions and misunderstandings to the contrary they still represent the reality of the past; they represent what the people formed out of the experiences of its past age under the domination of once powerful and to-day still effective motives, and if these distortions could be unraveled through the knowledge of all effective forces, one would surely discover the historic truth under this legendary material. The same holds true for the infantile reminiscences or for the phantasies of individuals. What a person thinks he recalls from his childhood, is not of an indifferent nature. As a rule the memory remnants, which he himself does not understand, conceal invaluable evidences of the most important features of his psychic development. As the psychoanalytic technique affords us excellent means for bringing to light this concealed material, we shall venture the attempt to fill the gaps in the history of Leonardo's life through the analysis of his infantile phantasy. And if we should not attain a satisfactory degree of certainty, we will have to console ourselves with the fact that so many other investigations about this great and mysterious man have met no better fate.

When we examine Leonardo's vulture-phantasy with the eyes of a psychoanalyst then it does not seem strange very long; we recall that we have often found similar structures in dreams, so that we may venture to translate this phantasy from its strange language into words that are universally understood. The translation then follows an erotic direction. Tail, "coda," is one of the most familiar symbols, as well as a substitutive designation of the male member

which is no less true in Italian than in other languages. The situation contained in the phantasy, that a vulture opened the mouth of the child and forcefully belabored it with its tail, corresponds to the idea of fellatio, a sexual act in which the member is placed into the mouth of the other person. Strangely enough this phantasy is altogether of a passive character; it resembles certain dreams and phantasies of women and of passive homosexuals who play the feminine part in sexual relations.

Let the reader be patient for a while and not flare up with indignation and refuse to follow psychoanalysis because in its very first applications it leads to an unpardonable slander of the memory of a great and pure man. For it is quite certain that this indignation will never solve for us the meaning of Leonardo's childhood phantasy; on the other hand, Leonardo has unequivocally acknowledged this phantasy, and we shall therefore not relinquish the expectation — or if you prefer the preconception — that like every psychic production such as dreams, visions and deliria this phantasy, too, must have some meaning. Let us therefore lend our unprejudiced ears for a while to psychoanalytic work which after all has not yet uttered the last word.

The desire to take the male member into the mouth and suck it, which is considered as one of the most disgusting of sexual perversions, is nevertheless a frequent occurrence among the women of our time — and as shown in old sculptures was the same in earlier times — and in the state of being in love seems to lose entirely its disgusting character. The physician encounters phantasies based on this desire, even in women who did not come to the knowledge of the possibility of such sexual gratification by reading V. Krafft-Ebing's *Psychopathia Sexualis* or through other information. It seems that it is quite easy for the women themselves to produce such wish-phantasies. Investigation then teaches us that this situation, so forcibly condemned by custom, may be traced to the most harmless origin. It is nothing but the elaboration of another situation in which we all once felt comfort, namely, when we were in the suckling-age ("when I was still in the cradle") and took the nipple of our mother's or wet-nurse's breast into our mouth to suck it. The organic impression of this first pleasure in our lives surely remains indelibly impregnated; when the child later learns to know the udder of the cow, which in function is a breast-nipple, but in shape and in position on the abdomen resembles the penis, it obtains the primary basis for the later formation of that disgusting sexual phantasy.

We now understand why Leonardo displaced the memory of the supposed experience with the vulture to his nursing period. This phantasy conceals nothing more or less than a reminiscence of nursing — or being nursed — at the

mother's breast, a scene both human and beautiful, which he as well as other artists undertook to depict with the brush in the form of the mother of God and her child. At all events, we also wish to maintain, something we do not as yet understand, that this reminiscence, equally significant for both sexes, was elaborated in the man Leonardo into a passive homosexual phantasy. For the present we shall not take up the question as to what connection there is between homosexuality and suckling at the mother's breast, we merely wish to recall that tradition actually designates Leonardo as a person of homosexual feelings. In considering this, it makes no difference whether that accusation against the youth Leonardo was justified or not. It is not the real activity but the nature of the feeling which causes us to decide whether to attribute to some one the characteristic of homosexuality.

Another incomprehensible feature of Leonardo's infantile phantasy next claims our interest. We interpret the phantasy of being wet-nursed by the mother and find that the mother is replaced by a vulture. Where does this vulture originate and how does he come into this place?

A thought now obtrudes itself which seems so remote that one is tempted to ignore it. In the sacred hieroglyphics of the old Egyptians the mother is represented by the picture of the vulture. These Egyptians also worshiped a motherly deity, whose head was vulture like, or who had many heads of which at least one or two was that of a vulture. The name of this goddess was pronounced *Mut*; we may question whether the sound similarity to our word mother (*Mutter*) is only accidental? So the vulture really has some connection with the mother, but of what help is that to us? Have we a right to attribute this knowledge to Leonardo when François Champollion first succeeded in reading hieroglyphics between 1790-1832?

It would also be interesting to discover in what way the old Egyptians came to choose the vulture as a symbol of motherhood. As a matter of fact the religion and culture of Egyptians were subjects of scientific interest even to the Greeks and Romans, and long before we ourselves were able to read the Egyptian monuments we had at our disposal some communications about them from preserved works of classical antiquity. Some of these writings belonged to familiar authors like Strabo, Plutarch, Aelianus Marcellus, and some bear unfamiliar names and are uncertain as to origin and time, like the hieroglyphica of Horapollo Nilus, and like the traditional book of oriental priestly wisdom bearing the godly name Hermes Trismegistos. From these sources we learn that the vulture was a symbol of motherhood because it was thought that this species of birds had only female vultures and no males. The natural history of the ancients shows a counterpart to this limitation among the scabæus beetles

which were revered by the Egyptians as godly, no females were supposed to exist.

But how does impregnation take place in vultures if only females exist? This is fully answered in a passage of Horapollo. At a certain time these birds stop in the midst of their flight, open their vagina and are impregnated by the wind.

Unexpectedly we have now reached a point where we can take something as quite probable which only shortly before we had to reject as absurd. It is quite possible that Leonardo was well acquainted with the scientific fable, according to which the Egyptians represented the idea of mother with the picture of the vulture. He was an omnivorous reader whose interest comprised all spheres of literature and knowledge. In the Codex Atlanticus we find an index of all books which he possessed at a certain time, as well as numerous notices about other books which he borrowed from friends, and according to the excerpts which Fr. Richter compiled from his drawings we can hardly overestimate the extent of his reading. Among these books there was no lack of older as well as contemporary works treating of natural history. All these books were already in print at that time, and it so happens that Milan was the principal place of the young art of book printing in Italy.

When we proceed further we come upon a communication which may raise to a certainty the probability that Leonardo knew the vulture fable. The erudite editor and commentator of Horapollo remarked in connection with the text (p. 172) cited before: *Caeterum hanc fabulam de vulturibus cupide amplexi sunt Patres Ecclesiastici, ut ita argumento ex rerum natura petito refutarent eos, qui Virginis partum negabant; itaque apud omnes fere hujus rei mentio occurrit.*

Hence the fable of the monosexuality and the conception of the vulture by no means remained as an indifferent anecdote as in the case of the analogous fable of the scarebæus beetles; that church fathers mastered it in order to have it ready as an argument from natural history against those who doubted the sacred history. If according the best information from antiquity the vultures were directed to let themselves be impregnated by the wind, why should the same thing not have happened even once in a human female? On account of this use the church fathers were “almost all” in the habit of relating this vulture fable, and now it can hardly remain doubtful that it also became known to Leonardo through so powerful a source.

The origin of Leonardo’s vulture phantasy can be conceived in the following manner: While reading in the writings of a church father or in a book on natural science that the vultures are all females and that they know to procreate without the coöperation of a male, a memory emerged in him which became transformed into that phantasy, but which meant to say that he also had been such a vulture

child, which had a mother but no father. An echo of pleasure which he experienced at his mother's breast was added to this in the manner as so old impressions alone can manifest themselves. The allusion to the idea of the holy virgin with the child, formed by the authors, which is so dear to every artist, must have contributed to it to make this phantasy seem to him valuable and important. For this helped him to identify himself with the Christ child, the comforter and savior of not alone this one woman.

When we break up an infantile phantasy we strive to separate the real memory content from the later motives which modify and distort the same. In the case of Leonardo we now think that we know the real content of the phantasy. The replacement of the mother by the vulture indicates that the child missed the father and felt himself alone with his mother. The fact of Leonardo's illegitimate birth fits in with his vulture phantasy; only on account of it was he able to compare himself with a vulture child. But we have discovered as the next definite fact from his youth that at the age of five years he had already been received in his father's home; when this took place, whether a few months following his birth, or a few weeks before the taking of the assessment of taxes, is entirely unknown to us. The interpretation of the vulture phantasy then steps in and wants to tell us that Leonardo did not spend the first decisive years of his life with his father and his step-mother but with his poor, forsaken, real mother, so that he had time to miss his father. This still seems to be a rather meager and rather daring result of the psychoanalytic effort, but on further reflection it will gain in significance. Certainty will be promoted by mentioning the actual relations in Leonardo's childhood. According to the reports, his father Ser Piero da Vinci married the prominent Donna Albiera during the year of Leonardo's birth; it was to the childlessness of this marriage that the boy owed his legalized reception into his father's or rather grandfather's house during his fifth year. However, it is not customary to offer an illegitimate offspring to a young woman's care at the beginning of marriage when she is still expecting to be blessed with children. Years of disappointment must have elapsed before it was decided to adopt the probably handsomely developed illegitimate child as a compensation for legitimate children who were vainly hoped for. It harmonizes best with the interpretation of the vulture-phantasy, if at least three years or perhaps five years of Leonardo's life had elapsed before he changed from his lonely mother to his father's home. But then it had already become too late. In the first three or four years of life impressions are fixed and modes of reactions are formed towards the outer world which can never be robbed of their importance by any later experiences.

If it is true that the incomprehensible childhood reminiscences and the

person's phantasies based on them always bring out the most significant of his psychic development, then the fact corroborated by the vulture phantasy, that Leonardo passed the first years of his life alone with his mother must have been a most decisive influence on the formation of his inner life. Under the effect of this constellation it could not have been otherwise than that the child which in his young life encountered one problem more than other children, should have begun to ponder very passionately over this riddle and thus should have become an investigator early in life. For he was tortured by the great questions where do children come from and what has the father to do with their origin. The vague knowledge of this connection between his investigation and his childhood history has later drawn from him the exclamation that it was destined that he should deeply occupy himself with the problem of the bird's flight, for already in his cradle he had been visited by a vulture. To trace the curiosity which is directed to the flight of the bird to the infantile sexual investigation will be a later task which will not be difficult to accomplish.

III

The element of the vulture represents to us the real memory content in Leonardo's childhood phantasy; the association into which Leonardo himself placed his phantasy threw a bright light on the importance of this content for his later life. In continuing the work of interpretation we now encounter the strange problem why this memory content was elaborated into a homosexual situation. The mother who nursed the child, or rather from whom the child suckled was transformed into a vulture which stuck its tail into the child's mouth. We maintain that the "coda" (tail) of the vulture, following the common substituting usages of language, cannot signify anything else but a male genital or penis. But we do not understand how the phantastic activity came to furnish precisely this maternal bird with the mark of masculinity, and in view of this absurdity we become confused at the possibility of reducing this phantastic structure to rational sense.

However, we must not despair. How many seemingly absurd dreams have we not forced to give up their sense! Why should it become more difficult to accomplish this in a childhood phantasy than in a dream!

Let us remember the fact that it is not good to find one isolated peculiarity, and let us hasten to add another to it which is still more striking.

The vulture-headed goddess *Mut* of the Egyptians, a figure of altogether impersonal character, as expressed by Drexel in Roscher's lexicon, was often fused with other maternal deities of living individuality like Isis and Hathor, but she retained besides her separate existence and reverence. It was especially characteristic of the Egyptian pantheon that the individual gods did not perish in this amalgamation. Besides the composition of deities the simple divine image remained in her independence. In most representations the vulture-headed maternal deity was formed by the Egyptians in a phallic manner, her body which was distinguished as feminine by its breasts also bore the masculine member in a state of erection.

The goddess *Mut* thus evinced the same union of maternal and paternal characteristics as in Leonardo's vulture phantasy. Should we explain this concurrence by the assumption that Leonardo knew from studying his book the androgynous nature of the maternal vulture? Such possibility is more than questionable; it seems that the sources accessible to him contained nothing of remarkable determination. It is more likely that here as there the agreement is to

be traced to a common, effective and unknown motive.

Mythology can teach us that the androgynous formation, the union of masculine and feminine sex characteristics, did not belong to the goddess Mut alone but also to other deities such as Isis and Hathor, but in the latter perhaps only insofar as they possessed also a motherly nature and became fused with the goddess Mut. It teaches us further that other Egyptian deities such as Neith of Sais out of whom the Greek Athene was later formed, were originally conceived as androgynous or dihermaphroditic, and that the same held true for many of the Greek gods, especially of the Dionysian circle, as well as for Aphrodite who was later restricted to a feminine love deity. Mythology may also offer the explanation that the phallus which was added to the feminine body was meant to denote the creative primitive force of nature, and that all these hermaphroditic deistic formations express the idea that only a union of the masculine and feminine elements can result in a worthy representation of divine perfection. But none of these observations explain the psychological riddle, namely, that the phantasy of men takes no offense at the fact that a figure which was to embody the essence of the mother should be provided with the mark of the masculine power which is the opposite of motherhood.

The explanation comes from the infantile sexual theories. There really was a time in which the male genital was found to be compatible with the representation of the mother. When the male child first directs his curiosity to the riddle of the sexual life, he is dominated by the interest for his own genitals. He finds this part of the body too valuable and too important to believe that it would be missing in other persons to whom he feels such a resemblance. As he cannot divine that there is still another equally valuable type of genital formation he must grasp the assumption that all persons, also women, possess such a member as he. This preconception is so firm in the youthful investigator that it is not destroyed even by the first observation of the genitals in little girls. His perception naturally tells him that there is something different here than in him, but he is unable to admit to himself as the content of this perception that he cannot find this member in girls. That this member may be missing is to him a dismal and unbearable thought, and he therefore seeks to reconcile it by deciding that it also exists in girls but it is still very small and that it will grow later. If this expectation does not appear to be fulfilled on later observation he has at his disposal another way of escape. The member also existed in the little girl but it was cut off and on its place there remained a wound. This progress of the theory already makes use of his own painful experience; he was threatened in the meantime that this important organ will be taken away from him if it will form too much of an interest for his occupation. Under the influence of this threat of

castration he now interprets his conception of the female genital, henceforth he will tremble for his masculinity, but at the same time he will look with contempt upon those unhappy creatures upon whom, in his opinion, this cruel punishment had already been visited.

Before the child came under the domination of the castration complex, at the time when he still held the woman at her full value, he began to manifest an intensive desire to look as an erotic activity of his impulse. He wished to see the genitals of other persons, originally probably because he wished to compare them with his own. The erotic attraction which emanated from the person of his mother soon reached its height in the longing to see her genital which he believed to be a penis. With the cognition acquired only later that the woman has no penis, this longing often becomes transformed into its opposite and gives place to disgust, which in the years of puberty may become the cause of psychic impotence, of misogyny and of lasting homosexuality. But the fixation on the once so vividly desired object, the penis of the woman, leaves ineradicable traces in the psychic life of the child, which has gone through that fragment of infantile sexual investigation with particular thoroughness. The fetich-like reverence for the feminine foot and shoe seems to take the foot only as a substitutive symbol for the once revered and since then missed member of the woman. The “braid-slashers” without knowing it play the part of persons who perform the act of castration on the female genital.

One will not gain any correct understanding of the activities of the infantile sexuality and probably will consider these communications unworthy of belief, as long as one does not relinquish the attitude of our cultural depreciation of the genitals and of the sexual functions in general. To understand the infantile psychic life one has to look to analogies from primitive times. For a long series of generations we have been in the habit of considering the genitals or *pudenda* as objects of shame, and in the case of more successful sexual repression as objects of disgust. The majority of those living to-day only reluctantly obey the laws of propagation, feeling thereby that their human dignity is being offended and degraded. What exists among us of the other conception of the sexual life is found only in the uncultivated and in the lower social strata; among the higher and more refined types it is concealed as culturally inferior, and its activity is ventured only under the embittered admonition of a guilty conscience. It was quite different in the primitive times of the human race. From the laborious collections of students of civilization one gains the conviction that the genitals were originally the pride and hope of living beings, they enjoyed divine worship, and the divine nature of their functions was transported to all newly acquired activities of mankind. Through sublimation of its essential elements there arose

innumerable god-figures, and at the time when the relation of official religions with sexual activity was already hidden from the general consciousness, secret cults labored to preserve it alive among a number of the initiated. In the course of cultural development it finally happened that so much godliness and holiness had been extracted from sexuality that the exhausted remnant fell into contempt. But considering the indestructibility which is in the nature of all psychic impressions one need not wonder that even the most primitive forms of genital worship could be demonstrated until quite recent times, and that language, customs and superstitions of present day humanity contain the remnants of all phases of this course of development.

Important biological analogies have taught us that the psychic development of the individual is a short repetition of the course of development of the race, and we shall therefore not find improbable what the psychoanalytic investigation of the child's psyche asserts concerning the infantile estimation of the genitals. The infantile assumption of the maternal penis is thus the common source of origin for the androgynous formation of the maternal deities like the Egyptian goddess Mut and the vulture's "coda" (tail) in Leonardo's childhood phantasy. As a matter of fact, it is only through misunderstanding that these deistic representations are designated hermaphroditic in the medical sense of the word. In none of them is there a union of the true genitals of both sexes as they are united in some deformed beings to the disgust of every human eye; but besides the breast as a mark of motherhood there is also the male member, just as it existed in the first imagination of the child about his mother's body. Mythology has retained for the faithful this revered and very early fancied bodily formation of the mother. The prominence given to the vulture-tail in Leonardo's phantasy we can now translate as follows: At that time when I directed my tender curiosity to my mother I still adjudged to her a genital like my own. A further testimonial of Leonardo's precocious sexual investigation, which in our opinion became decisive for his entire life.

A brief reflection now admonishes us that we should not be satisfied with the explanation of the vulture-tail in Leonardo's childhood phantasy. It seems as if it contained more than we as yet understand. For its more striking feature really consisted in the fact that the nursing at the mother's breast was transformed into being nursed, that is into a passive act which thus gives the situation an undoubted homosexual character. Mindful of the historical probability that Leonardo behaved in life as a homosexual in feeling, the question obtrudes itself whether this phantasy does not point to a causal connection between Leonardo's childhood relations to his mother and the later manifest, if only ideal, homosexuality. We would not venture to draw such conclusion from Leonardo's

disfigured reminiscence were it not for the fact that we know from our psychoanalytic investigation of homosexual patients that such a relation exists, indeed it really is an intimate and necessary relation.

Homosexual men who have started in our times an energetic action against the legal limitations of their sexual activity are fond of representing themselves through theoretical spokesmen as evincing a sexual variation, which may be distinguished from the very beginning, as an intermediate stage of sex or as “a third sex.” In other words, they maintain that they are men who are forced by organic determinants originating in the germ to find that pleasure in the man which they cannot feel in the woman. As much as one would wish to subscribe to their demands out of humane considerations, one must nevertheless exercise reserve regarding their theories which were formulated without regard for the psychic genesis of homosexuality. Psychoanalysis offers the means to fill this gap and to put to test the assertions of the homosexuals. It is true that psychoanalysis fulfilled this task in only a small number of people, but all investigation thus far undertaken brought the same surprising results. In all our male homosexuals there was a very intensive erotic attachment to a feminine person, as a rule to the mother, which was manifest in the very first period of childhood and later entirely forgotten by the individual. This attachment was produced or favored by too much love from the mother herself, but was also furthered by the retirement or absence of the father during the childhood period. Sadger emphasizes the fact that the mothers of his homosexual patients were often man-women, or women with energetic traits of character who were able to crowd out the father from the place allotted to him in the family. I have sometimes observed the same thing, but I was more impressed by those cases in which the father was absent from the beginning or disappeared early so that the boy was altogether under feminine influence. It almost seems that the presence of a strong father would assure for the son the proper decision in the selection of his object from the opposite sex.

Following this primary stage, a transformation takes place whose mechanisms we know but whose motive forces we have not yet grasped. The love of the mother cannot continue to develop consciously so that it merges into repression. The boy represses the love for the mother by putting himself in her place, by identifying himself with her, and by taking his own person as a model through the similarity of which he is guided in the selection of his love object. He thus becomes homosexual; as a matter of fact he returns to the stage of autoerotism, for the boys whom the growing adult now loves are only substitutive persons or revivals of his own childish person, whom he loves in the same way as his mother loved him. We say that he finds his love object on the road to narcissism,

for the Greek legend called a boy Narcissus to whom nothing was more pleasing than his own mirrored image, and who became transformed into a beautiful flower of this name.

Deeper psychological discussions justify the assertion that the person who becomes homosexual in this manner remains fixed in his unconscious on the memory picture of his mother. By repressing the love for his mother he conserves the same in his unconscious and henceforth remains faithful to her. When as a lover he seems to pursue boys, he really thus runs away from women who could cause him to become faithless to his mother. Through direct observation of individual cases we could demonstrate that he who is seemingly receptive only of masculine stimuli is in reality influenced by the charms emanating from women just like a normal person, but each and every time he hastens to transfer the stimulus he received from the woman to a male object and in this manner he repeats again and again the mechanism through which he acquired his homosexuality.

It is far from us to exaggerate the importance of these explanations concerning the psychic genesis of homosexuality. It is quite clear that they are in crass opposition to the official theories of the homosexual spokesmen, but we are aware that these explanations are not sufficiently comprehensive to render possible a final explanation of the problem. What one calls homosexual for practical purposes may have its origin in a variety of psychosexual inhibiting processes, and the process recognized by us is perhaps only one among many, and has reference only to one type of "homosexuality." We must also admit, that the number of cases in our homosexual type which shows the conditions required by us, exceeds by far those cases in which the resulting effect really appears, so that even we cannot reject the supposed coöperation of unknown constitutional factors from which one was otherwise wont to deduce the whole of homosexuality. As a matter of fact there would be no occasion for entering into the psychic genesis of the form of homosexuality studied by us if there were not a strong presumption that Leonardo, from whose vulture-phantasy we started, really belonged to this one type of homosexuality.

As little as is known concerning the sexual behavior of the great artist and investigator, we must still trust to the probability that the testimonies of his contemporaries did not go far astray. In the light of this tradition he appears to us as a man whose sexual need and activity were extraordinarily low, as if a higher striving had raised him above the common animal need of mankind. It may be open to doubt whether he ever sought direct sexual gratification, and in what manner, or whether he could dispense with it altogether. We are justified, however, to look also in him for those emotional streams which imperatively

force others to the sexual act, for we cannot imagine a human psychic life in whose development the sexual desire in the broadest sense, the libido, has not had its share, whether the latter has withdrawn itself far from the original aim or whether it was detained from being put into execution.

Anything but traces of unchanged sexual desire we need not expect in Leonardo. These point however to one direction and allow us to count him among homosexuals. It has always been emphasized that he took as his pupils only strikingly handsome boys and youths. He was kind and considerate towards them, he cared for them and nursed them himself when they were ill, just like a mother nurses her children, as his own mother might have cared for him. As he selected them on account of their beauty rather than their talent, none of them — Cesare da Sesto, G. Boltraffio, Andrea Salaino, Francesco Melzi and the others — ever became a prominent artist. Most of them could not make themselves independent of their master and disappeared after his death without leaving a more definite physiognomy to the history of art. The others who by their productions earned the right to call themselves his pupils, as Luini and Bazzi, nicknamed Sodoma, he probably did not know personally.

We realize that we will have to face the objection that Leonardo's behavior towards his pupils surely had nothing to do with sexual motives, and permits no conclusion as to his sexual peculiarity. Against this we wish to assert with all caution that our conception explains some strange features in the master's behavior which otherwise would have remained enigmatical. Leonardo kept a diary; he made entries in his small hand, written from right to left which were meant only for himself. It is to be noted that in this diary he addressed himself with "thou": "Learn from master Lucca the multiplication of roots." "Let master d'Abacco show thee the square of the circle." Or on the occasion of a journey he entered in his diary: "I am going to Milan to look after the affairs of my garden ... order two pack-sacks to be made. Ask Boltraffio to show thee his turning-lathe and let him polish a stone on it. — Leave the book to master Andrea il Todesco." Or he wrote a resolution of quite different significance: "Thou must show in thy treatise that the earth is a star, like the moon or resembling it, and thus prove the nobility of our world."

In this diary, which like the diaries of other mortals often skim over the most important events of the day with only few words or ignore them altogether, one finds a few entries which on account of their peculiarity are cited by all of Leonardo's biographers. They show notations referring to the master's petty expenses, which are recorded with painful exactitude as if coming from a pedantic and strictly parsimonious family father, while there is nothing to show that he spent greater sums, or that the artist was well versed in household

management. One of these notes refers to a new cloak which he bought for his pupil Andrea Salaino:

Silver brocade	Lira	15	Soldi	4
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Crimson velvet for trimming	“	9	“	0
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Braid	“	0	“	9
-------	---	----------	---	----------

Buttons	“	0	“	12
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Another very detailed notice gives all the expenses which he incurred through the bad qualities and the thieving tendencies of another pupil or model: “On 21st day of April, 1490, I started this book and started again the horse. Jacomo came to me on Magdalene day, 1490, at the age of ten years (marginal note: thievish, mendacious, willful, gluttonous). On the second day I ordered for him two shirts, a pair of pants, and a jacket, and as I put the money away to pay for the things named he stole the money from my purse, and it was never possible to make him confess, although I was absolutely sure of it (marginal note: 4 Lira ...).” So the report continues concerning the misdeeds of the little boy and concludes with the expense account: “In the first year, a cloak, Lira 2: 6 shirts, Lira 4: 3 jackets, Lira 6: 4 pair of socks, Lira 7, etc.”

Leonardo’s biographers, to whom nothing was further than to solve the riddle in the psychic life of their hero from these slight weaknesses and peculiarities, were wont to remark in connection with these peculiar accounts that they emphasized the kindness and consideration of the master for his pupils. They forget thereby that it is not Leonardo’s behavior that needs an explanation, but the fact that he left us these testimonies of it. As it is impossible to ascribe to him the motive of smuggling into our hands proofs of his kindness, we must assume that another affective motive caused him to write this down. It is not easy to conjecture what this motive was, and we could not give any if not for another account found among Leonardo’s papers which throws a brilliant light on these peculiarly petty notices about his pupils’ clothes, and others of a kind:

Burial expenses following the death of Caterina	27	florins
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2 pounds wax	18	“
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Cataphalc	12	“
-----------	-----------	---

For the transportation and erection of the cross	4	“
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Pall bearers	8	“
--------------	----------	---

To 4 priests and 4 clerics	20	“
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Ringling of bells	2	“
-------------------	----------	---

To grave diggers	16	“
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For the approval — to the officials	1	“
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To sum up	108	florins
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Previous expenses:

1

To the doctor	4	florins
For sugar and candles	12	“
	16	florins
Sum total	124	florins

The writer Merejkowski is the only one who can tell us who this Caterina was. From two different short notices he concludes that she was the mother of Leonardo, the poor peasant woman from Vinci, who came to Milan in 1493 to visit her son then 41 years old. While on this visit she fell ill and was taken to the hospital by Leonardo, and following her death she was buried by her son with such sumptuous funeral.

This deduction of the psychological writer of romances is not capable of proof, but it can lay claim to so many inner probabilities, it agrees so well with everything we know besides about Leonardo's emotional activity that I cannot refrain from accepting it as correct. Leonardo succeeded in forcing his feelings under the yoke of investigation and in inhibiting their free utterance, but even in him there were episodes in which the suppression obtained expression, and one of these was the death of his mother whom he once loved so ardently. Through this account of the burial expenses he represents to us the mourning of his mother in an almost unrecognizable distortion. We wonder how such a distortion could have come about, and we certainly cannot grasp it when viewed under normal mental processes. But similar mechanisms are familiar to us under the abnormal conditions of neuroses, and especially in the so-called *compulsion neurosis*. Here one can observe how the expressions of more intensive feelings have been displaced to trivial and even foolish performances. The opposing forces succeeded in debasing the expression of these repressed feelings to such an extent that one is forced to estimate the intensity of these feelings as extremely unimportant, but the imperative compulsion with which these insignificant acts express themselves betrays the real force of the feelings which are rooted in the unconscious, which consciousness would wish to disavow.

Only by bearing in mind the mechanisms of compulsion neurosis can one explain Leonardo's account of the funeral expenses of his mother. In his unconscious he was still tied to her as in childhood, by erotically tinged feelings; the opposition of the repression of this childhood love which appeared later stood in the way of erecting to her in his diary a different and more dignified monument, but what resulted as a compromise of this neurotic conflict had to be put in operation and hence the account was entered in the diary which thus came to the knowledge of posterity as something incomprehensible.

It is not venturing far to transfer the interpretation obtained from the funeral expenses to the accounts dealing with his pupils. Accordingly we would say that here also we deal with a case in which Leonardo's meager remnants of libidinous feelings compulsively obtained a distorted expression. The mother and the pupils, the very images of his own boyish beauty, would be his sexual objects — as far as his sexual repression dominating his nature would allow such manifestations — and the compulsion to note with painful circumstantiality his expenses on their behalf, would designate the strange betrayal of his rudimentary conflicts. From this we would conclude that Leonardo's love-life really belonged to that type of homosexuality, the psychic development of which we were able to disclose, and the appearance of the homosexual situation in his vulture-phantasy would become comprehensible to us, for it states nothing more or less than what we have asserted before concerning that type. It requires the following interpretation: Through the erotic relations to my mother I became a homosexual.

IV

The vulture phantasy of Leonardo still absorbs our interest. In words which only too plainly recall a sexual act (“and has many times struck against my lips with his tail”), Leonardo emphasizes the intensity of the erotic relations between the mother and the child. A second memory content of the phantasy can readily be conjectured from the association of the activity of the mother (of the vulture) with the accentuation of the mouth zone. We can translate it as follows: My mother has pressed on my mouth innumerable passionate kisses. The phantasy is composed of the memories of being nursed and of being kissed by the mother.



MONA LISA

A kindly nature has bestowed upon the artist the capacity to express in artistic productions his most secret psychic feelings hidden even to himself, which powerfully affect outsiders who are strangers to the artist without their being able to state whence this emotivity comes. Should there be no evidence in Leonardo's work of that which his memory retained as the strongest impression of his childhood? One would have to expect it. However, when one considers

what profound transformations an impression of an artist has to experience before it can add its contribution to the work of art, one is obliged to moderate considerably his expectation of demonstrating something definite. This is especially true in the case of Leonardo.

He who thinks of Leonardo's paintings will be reminded by the remarkably fascinating and puzzling smile which he enchanted on the lips of all his feminine figures. It is a fixed smile on elongated, sinuous lips which is considered characteristic of him and is preferentially designated as "Leonardesque." In the singular and beautiful visage of the Florentine Monna Lisa del Giocondo it has produced the greatest effect on the spectators and even perplexed them. This smile was in need of an interpretation, and received many of the most varied kind but none of them was considered satisfactory. As Gruyer puts it: "It is almost four centuries since Monna Lisa causes all those to lose their heads who have looked upon her for some time."

Muther states: "What fascinates the spectator is the demoniacal charm of this smile. Hundreds of poets and writers have written about this woman, who now seems to smile upon us seductively and now to stare coldly and lifelessly into space, but nobody has solved the riddle of her smile, nobody has interpreted her thoughts. Everything, even the scenery is mysterious and dream-like, trembling as if in the sultriness of sensuality."

The idea that two diverse elements were united in the smile of Monna Lisa has been felt by many critics. They therefore recognize in the play of features of the beautiful Florentine lady the most perfect representation of the contrasts dominating the love-life of the woman which is foreign to man, as that of reserve and seduction, and of most devoted tenderness and inconsiderateness in urgent and consuming sensuality. Müntz expresses himself in this manner: "One knows what indecipherable and fascinating enigma Monna Lisa Gioconda has been putting for nearly four centuries to the admirers who crowd around her. No artist (I borrow the expression of the delicate writer who hides himself under the pseudonym of Pierre de Corlay) has ever translated in this manner the very essence of femininity: the tenderness and coquetry, the modesty and quiet voluptuousness, the whole mystery of the heart which holds itself aloof, of a brain which reflects, and of a personality who watches itself and yields nothing from herself except radiance...." The Italian Angelo Conti saw the picture in the Louvre illumined by a ray of the sun and expressed himself as follows: "The woman smiled with a royal calmness, her instincts of conquest, of ferocity, the entire heredity of the species, the will of seduction and ensnaring, the charm of the deceiver, the kindness which conceals a cruel purpose, all that appears and disappears alternately behind the laughing veil and melts into the poem of her

smile.... Good and evil, cruelty and compassion, graceful and cat-like, she laughed....”

Leonardo painted this picture four years, perhaps from 1503 until 1507, during his second sojourn in Florence when he was about the age of fifty years. According to Vasari he applied the choicest artifices in order to divert the lady during the sittings and to hold that smile firmly on her features. Of all the gracefulness that his brush reproduced on the canvas at that time the picture preserves but very little in its present state. During its production it was considered the highest that art could accomplish; it is certain, however, that it did not satisfy Leonardo himself, that he pronounced it as unfinished and did not deliver it to the one who ordered it, but took it with him to France where his benefactor Francis I, acquired it for the Louvre.

Let us leave the physiognomic riddle of Monna Lisa unsolved, and let us note the unequivocal fact that her smile fascinated the artist no less than all the spectators for these 400 years. This captivating smile had thereafter returned in all of his pictures and in those of his pupils. As Leonardo's Monna Lisa was a portrait we cannot assume that he has added to her face a trait of his own so difficult to express which she herself did not possess. It seems, we cannot help but believe, that he found this smile in his model and became so charmed by it that from now on he endowed it on all the free creations of his phantasy. This obvious conception is, e.g., expressed by A. Konstantinowa in the following manner:

“During the long period in which the master occupied himself with the portrait of Monna Lisa del Gioconda, he entered into the physiognomic delicacies of this feminine face with such sympathy of feeling that he transferred these creatures, especially the mysterious smile and the peculiar glance, to all faces which he later painted or drew. The mimic peculiarity of Gioconda can even be perceived in the picture of John the Baptist in the Louvre. But above all they are distinctly recognized in the features of Mary in the picture of St. Anne of the Louvre.”

But the case could have been different. The need for a deeper reason for the fascination which the smile of Gioconda exerted on the artist from which he could not rid himself has been felt by more than one of his biographers. W. Pater, who sees in the picture of Monna Lisa the embodiment of the entire erotic experience of modern man, and discourses so excellently on “that unfathomable smile always with a touch of something sinister in it, which plays over all Leonardo's work,” leads us to another track when he says:

“Besides, the picture is a portrait. From childhood we see this image defining itself on the fabric of his dream; and but for express historical testimony, we might fancy that this was but his ideal lady, embodied and beheld at last.”

Herzfeld surely must have had something similar in mind when stating that in Monna Lisa Leonardo encountered himself and therefore found it possible to put so much of his own nature into the picture, “whose features from time immemorial have been imbedded with mysterious sympathy in Leonardo’s soul.”

Let us endeavor to clear up these intimations. It was quite possible that Leonardo was fascinated by the smile of Monna Lisa, because it had awakened something in him which had slumbered in his soul for a long time, in all probability an old memory. This memory was of sufficient importance to stick to him once it had been aroused; he was forced continually to provide it with new expression. The assurance of Pater that we can see an image like that of Monna Lisa defining itself from Leonardo’s childhood on the fabric of his dreams, seems worthy of belief and deserves to be taken literally.

Vasari mentions as Leonardo’s first artistic endeavors, “heads of women who laugh.” The passage, which is beyond suspicion, as it is not meant to prove anything, reads more precisely as follows: “He formed in his youth some laughing feminine heads out of lime, which have been reproduced in plaster, and some heads of children, which were as beautiful as if modeled by the hands of a master...”

Thus we discover that his practice of art began with the representation of two kinds of objects, which would perforce remind us of the two kinds of sexual objects which we have inferred from the analysis of his vulture phantasy. If the beautiful children’s heads were reproductions of his own childish person, then the laughing women were nothing else but reproductions of Caterina, his mother, and we are beginning to have an inkling of the possibility that his mother possessed that mysterious smile which he lost, and which fascinated him so much when he found it again in the Florentine lady.



SAINT ANNE

The painting of Leonardo which in point of time stands nearest to the Monna Lisa is the so-called Saint Anne of the Louvre, representing Saint Anne, Mary and the Christ child. It shows the Leonardesque smile most beautifully portrayed in the two feminine heads. It is impossible to find out how much earlier or later than the portrait of Monna Lisa Leonardo began to paint this picture. As both works extended over years, we may well assume that they occupied the master

simultaneously. But it would best harmonize with our expectation if precisely the absorption in the features of Monna Lisa would have instigated Leonardo to form the composition of Saint Anne from his phantasy. For if the smile of Gioconda had conjured up in him the memory of his mother, we would naturally understand that he was first urged to produce a glorification of motherhood, and to give back to her the smile he found in that prominent lady. We may thus allow our interest to glide over from the portrait of Monna Lisa to this other hardly less beautiful picture, now also in the Louvre.

Saint Anne with the daughter and grandchild is a subject seldom treated in the Italian art of painting; at all events Leonardo's representation differs widely from all that is otherwise known. Muther states:

"Some masters like Hans Fries, the older Holbein, and Girolamo dei Libri, made Anne sit near Mary and placed the child between the two. Others like Jakob Cornelicz in his Berlin pictures, represented Saint Anne as holding in her arm the small figure of Mary upon which sits the still smaller figure of the Christ child." In Leonardo's picture Mary sits on her mother's lap, bent forward and is stretching out both arms after the boy who plays with a little lamb, and must have slightly maltreated it. The grandmother has one of her unconcealed arms propped on her hip and looks down on both with a blissful smile. The grouping is certainly not quite unconstrained. But the smile which is playing on the lips of both women, although unmistakably the same as in the picture of Monna Lisa, has lost its sinister and mysterious character; it expresses a calm blissfulness.

On becoming somewhat engrossed in this picture it suddenly dawns upon the spectator that only Leonardo could have painted this picture, as only he could have formed the vulture phantasy. This picture contains the synthesis of the history of Leonardo's childhood, the details of which are explainable by the most intimate impressions of his life. In his father's home he found not only the kind step-mother Donna Albiera, but also the grandmother, his father's mother, Monna Lucia, who we will assume was not less tender to him than grandmothers are wont to be. This circumstance must have furnished him with the facts for the representation of a childhood guarded by a mother and grandmother. Another striking feature of the picture assumes still greater significance. Saint Anne, the mother of Mary and the grandmother of the boy who must have been a matron, is formed here perhaps somewhat more mature and more serious than Saint Mary, but still as a young woman of unfaded beauty. As a matter of fact Leonardo gave the boy two mothers, the one who stretched out her arms after him and another who is seen in the background, both are represented with the blissful smile of maternal happiness. This peculiarity of the picture has not failed to excite the wonder of the authors. Muther, for instance, believes that Leonardo

could not bring himself to paint old age, folds and wrinkles, and therefore formed also Anne as a woman of radiant beauty. Whether one can be satisfied with this explanation is a question. Other writers have taken occasion to deny generally the sameness of age of mother and daughter. However, Muther's tentative explanation is sufficient proof for the fact that the impression of Saint Anne's youthful appearance was furnished by the picture and is not an imagination produced by a tendency.

Leonardo's childhood was precisely as remarkable as this picture. He has had two mothers, the first his true mother, Caterina, from whom he was torn away between the age of three and five years, and a young tender step-mother, Donna Albiera, his father's wife. By connecting this fact of his childhood with the one mentioned above and condensing them into a uniform fusion, the composition of Saint Anne, Mary and the Child, formed itself in him. The maternal form further away from the boy designated as grandmother, corresponds in appearance and in spatial relation to the boy, with the real first mother, Caterina. With the blissful smile of Saint Anne the artist actually disavowed and concealed the envy which the unfortunate mother felt when she was forced to give up her son to her more aristocratic rival, as once before her lover.

Our feeling that the smile of Monna Lisa del Gioconda awakened in the man the memory of the mother of his first years of childhood would thus be confirmed from another work of Leonardo. Following the production of Monna Lisa, Italian artists depicted in Madonnas and prominent ladies the humble dipping of the head and the peculiar blissful smile of the poor peasant girl Caterina, who brought to the world the noble son who was destined to paint, investigate, and suffer.

When Leonardo succeeded in reproducing in the face of Monna Lisa the double sense comprised in this smile, namely, the promise of unlimited tenderness, and sinister threat (in the words of Pater), he remained true even in this to the content of his earliest reminiscence. For the love of the mother became his destiny, it determined his fate and the privations which were in store for him. The impetuosity of the caressing to which the vulture phantasy points was only too natural. The poor forsaken mother had to give vent through mother's love to all her memories of love enjoyed as well as to all her yearnings for more affection; she was forced to it, not only in order to compensate herself for not having a husband, but also the child for not having a father who wanted to love it. In the manner of all ungratified mothers she thus took her little son in place of her husband, and robbed him of a part of his virility by the too early maturing of his eroticism. The love of the mother for the suckling whom she nourishes and cares for is something far deeper reaching than her later affection

for the growing child. It is of the nature of a fully gratified love affair, which fulfills not only all the psychic wishes but also all physical needs, and when it represents one of the forms of happiness attainable by man it is due, in no little measure, to the possibility of gratifying without reproach also wish feelings which were long repressed and designated as perverse. Even in the happiest recent marriage the father feels that his child, especially the little boy has become his rival, and this gives origin to an antagonism against the favorite one which is deeply rooted in the unconscious.

When in the prime of his life Leonardo re-encountered that blissful and ecstatic smile as it had once encircled his mother's mouth in caressing, he had long been under the ban of an inhibition, forbidding him ever again to desire such tenderness from women's lips. But as he had become a painter he endeavored to reproduce this smile with his brush and furnish all his pictures with it, whether he executed them himself or whether they were done by his pupils under his direction, as in Leda, John, and Bacchus. The latter two are variations of the same type. Muther says: "From the locust eater of the Bible Leonardo made a Bacchus, an Apollo, who with a mysterious smile on his lips, and with his soft thighs crossed, looks on us with infatuated eyes." These pictures breathe a mysticism into the secret of which one dares not penetrate; at most one can make the effort to construct the connection to Leonardo's earlier productions. The figures are again androgynous but no longer in the sense of the vulture phantasy, they are pretty boys of feminine tenderness with feminine forms; they do not cast down their eyes but gaze mysteriously triumphant, as if they knew of a great happy issue concerning which one must remain quiet; the familiar fascinating smile leads us to infer that it is a love secret. It is possible that in these forms Leonardo disavowed and artistically conquered the unhappiness of his love life, in that he represented the wish fulfillment of the boy infatuated with his mother in such blissful union of the male and female nature.



JOHN THE BAPTIST

V

Among the entries in Leonardo's diaries there is one which absorbs the reader's attention through its important content and on account of a small formal error. In July, 1504, he wrote:

"Adi 9 Luglio, 1504, mercoledì, a ore 7 morì Ser Piero da Vinci notalio al palazzo del Potestà, mio padre, a ore 7. Era d'età d'anni 80, lasciò 10 figlioli maschi e 2 feminine."

The notice as we see deals with the death of Leonardo's father. The slight error in its form consists in the fact that in the computation of the time "at 7 o'clock" is repeated two times, as if Leonardo had forgotten at the end of the sentence that he had already written it at the beginning. It is only a triviality to which any one but a psychoanalyst would pay no attention. Perhaps he would not even notice it, or if his attention would be called to it he would say "that can happen to anybody during absent-mindedness or in an affective state and has no further meaning."

The psychoanalyst thinks differently; to him nothing is too trifling as a manifestation of hidden psychic processes; he has long learned that such forgetting or repetition is full of meaning, and that one is indebted to the "absent-mindedness" when it makes possible the betrayal of otherwise concealed feelings.

We would say that, like the funeral account of Caterina and the expense account of the pupils, this notice, too, corresponds to a case in which Leonardo was unsuccessful in suppressing his affects, and the long hidden feeling forcibly obtained a distorted expression. Also the form is similar, it shows the same pedantic precision, the same pushing forward of numbers.

We call such a repetition a perseveration. It is an excellent means to indicate the affective accentuation. One recalls for example Saint Peter's angry speech against his unworthy representative on earth, as given in Dante's *Paradiso*:

"Quegli ch'usurpa in terra il luogo mio
Il luogo mio, il luogo mio, che vaca
Nella presenza del Figliuol di Dio,
Fatto ha del cimiterio mio cloaca."

Without Leonardo's affective inhibition the entry into the diary could perhaps have read as follows: To-day at 7 o'clock died my father, Ser Piero da Vinci, my poor father! But the displacement of the perseveration to the most indifferent

determination of the obituary to dying-hour robs the notice of all pathos and lets us recognize that there was something here to conceal and to suppress.

Ser Piero da Vinci, notary and descendant of notaries, was a man of great energy who attained respect and affluence. He was married four times, the two first wives died childless, and not till the third marriage has he gotten the first legitimate son, in 1476, when Leonardo was 24 years old, and had long ago changed his father's home for the studio of his master Verrocchio. With the fourth and last wife whom he married when he was already in the fifties he begot nine sons and two daughters.

To be sure the father also assumed importance in Leonardo's psychosexual development, and what is more, it was not only in a negative sense, through his absence during the boy's first childhood years, but also directly through his presence in his later childhood. He who as a child desires his mother, cannot help wishing to put himself in his father's place, to identify himself with him in his phantasy and later make it his life's task to triumph over him. As Leonardo was not yet five years old when he was received into his paternal home, the young step-mother, Albiera, certainly must have taken the place of his mother in his feeling, and this brought him into that relation of rivalry to his father which may be designated as normal. As is known, the preference for homosexuality did not manifest itself till near the years of puberty. When Leonardo accepted this preference the identification with the father lost all significance for his sexual life, but continued in other spheres of non-erotic activity. We hear that he was fond of luxury and pretty raiments, and kept servants and horses, although according to Vasari's words "he hardly possessed anything and worked little." We shall not hold his artistic taste entirely responsible for all these special likings; we recognize in them also the compulsion to copy his father and to excel him. He played the part of the great gentleman to the poor peasant girl, hence the son retained the incentive that he also play the great gentleman, he had the strong feeling "to out-herod Herod," and to show his father exactly how the real high rank looks.

Whoever works as an artist certainly feels as a father to his works. The identification with his father had a fateful result in Leonardo's works of art. He created them and then troubled himself no longer about them, just as his father did not trouble himself about him. The later worriments of his father could change nothing in this compulsion, as the latter originated from the impressions of the first years of childhood, and the repression having remained unconscious was incorrigible through later experiences.

At the time of the Renaissance, and even much later, every artist was in need of a gentleman of rank to act as his benefactor. This patron was wont to give the

artist commissions for work and entirely controlled his destiny. Leonardo found his patron in Lodovico Sforza, nicknamed Il Moro, a man of high aspirations, ostentations, diplomatically astute, but of an unstable and unreliable character. In his court in Milan, Leonardo spent the best period of his life, while in his service he evinced his most uninhibited productive activity as is evidenced in The Last Supper, and in the equestrian statue of Francesco Sforza. He left Milan before the catastrophe struck Lodovico Moro, who died a prisoner in a French prison. When the news of his benefactor's fate reached Leonardo he made the following entry in his diary: "The duke has lost state, wealth, and liberty, not one of his works will be finished by himself." It is remarkable and surely not without significance that he here raises the same reproach to his benefactor that posterity was to apply to him, as if he wanted to lay the responsibility to a person who substituted his father-series, for the fact that he himself left his works unfinished. As a matter of fact he was not wrong in what he said about the Duke.

However, if the imitation of his father hurt him as an artist, his resistance against the father was the infantile determinant of his perhaps equally vast accomplishment as an artist. According to Merejkowski's beautiful comparison he was like a man who awoke too early in the darkness, while the others were all still asleep. He dared utter this bold principle which contains the justification for all independent investigation: "*Chi dispute allegando l'autorità non adopra l'ingegno ma piuttosto la memoria*" (Whoever refers to authorities in disputing ideas, works with his memory rather than with his reason). Thus he became the first modern natural philosopher, and his courage was rewarded by an abundance of cognitions and suggestions; since the Greek period he was the first to investigate the secrets of nature, relying entirely on his observation and his own judgment. But when he learned to depreciate authority and to reject the imitation of the "ancients" and constantly pointed to the study of nature as the source of all wisdom, he only repeated in the highest sublimation attainable to man, which had already obtruded itself on the little boy who surveyed the world with wonder. To retranslate the scientific abstractions into concrete individual experiences, we would say that the "ancients" and authority only corresponded to the father, and nature again became the tender mother who nourished him. While in most human beings to-day, as in primitive times, the need for a support of some authority is so imperative that their world becomes shaky when their authority is menaced, Leonardo alone was able to exist without such support; but that would not have been possible had he not been deprived of his father in the first years of his life. The boldness and independence of his later scientific investigation presupposes that his infantile sexual investigation was not inhibited by his father, and this same spirit of scientific independence was continued by

his withdrawing from sex.

If any one like Leonardo escapes in his childhood his father's intimidation and later throws off the shackles of authority in his scientific investigation, it would be in gross contradiction to our expectation if we found that this same man remained a believer and unable to withdraw from dogmatic religion. Psychoanalysis has taught us the intimate connection between the father complex and belief in God, and daily demonstrates to us how youthful persons lose their religious belief as soon as the authority of the father breaks down. In the parental complex we thus recognize the roots of religious need; the almighty, just God, and kindly nature appear to us as grand sublimations of father and mother, or rather as revivals and restorations of the infantile conceptions of both parents. Religiousness is biologically traced to the long period of helplessness and need of help of the little child. When the child grows up and realizes his loneliness and weakness in the presence of the great forces of life, he perceives his condition as in childhood and seeks to disavow his despair through a regressive revival of the protecting forces of childhood.

It does not seem that Leonardo's life disproves this conception of religious belief. Accusations charging him with irreligiousness, which in those times was equivalent to renouncing Christianity, were brought against him already in his lifetime, and were clearly described in the first biography given by Vasari. In the second edition of his *Vite* (1568) Vasari left out this observation. In view of the extraordinary sensitiveness of his age in matters of religion it is perfectly comprehensible to us why Leonardo refrained from directly expressing his position to Christianity in his notes. As investigator he did not permit himself to be misled by the account of the creation of the holy scriptures; for instance, he disputed the possibility of a universal flood, and in geology he was as unscrupulous in calculating with hundred thousands of years as modern investigators.

Among his "prophecies" one finds some things that would perforce offend the sensitive feelings of a religious Christian, *e.g.* Praying to the images of Saints, reads as follows:

"People talk to people who perceive nothing, who have open eyes and see nothing; they shall talk to them and receive no answer; they shall adore those who have ears and hear nothing; they shall burn lamps for those who do not see."

Or: Concerning mourning on Good Friday (p. 297):

"In all parts of Europe great peoples will bewail the death of one man who died in the Orient."

It was asserted of Leonardo's art that he took away the last remnant of

religious attachment from the holy figures and put them into human form in order to depict in them great and beautiful human feelings. Muther praises him for having overcome the feeling of decadence, and for having returned to man the right of sensuality and pleasurable enjoyment. The notices which show Leonardo absorbed in fathoming the great riddles of nature do not lack any expressions of admiration for the creator, the last cause of all these wonderful secrets, but nothing indicates that he wished to hold any personal relation to this divine force. The sentences which contain the deep wisdom of his last years breathe the resignation of the man who subjects himself to the laws of nature and expects no alleviation from the kindness or grace of God. There is hardly any doubt that Leonardo had vanquished dogmatic as well as personal religion, and through his work of investigation he had withdrawn far from the world aspect of the religious Christian.

From our views mentioned before in the development of the infantile psychic life, it becomes clear that also Leonardo's first investigations in childhood occupied themselves with the problems of sexuality. But he himself betrays it to us through a transparent veil, in that he connects his impulse to investigate with the vulture phantasy, and in emphasizing the problem of the flight of the bird as one whose elaboration devolved upon him through special concatenations of fate. A very obscure as well as a prophetically sounding passage in his notes dealing with the flight of the bird demonstrates in the nicest way with how much affective interest he clung to the wish that he himself should be able to imitate, the art of flying: "The human bird shall take his first flight, filling the world with amazement, all writings with his fame, and bringing eternal glory to the nest whence he sprang." He probably hoped that he himself would sometimes be able to fly, and we know from the wish fulfilling dreams of people what bliss one expects from the fulfillment of this hope.

But why do so many people dream that they are able to fly? Psychoanalysis answers this question by stating that to fly or to be a bird in the dream is only a concealment of another wish, to the recognition of which one can reach by more than one linguistic or objective bridge. When the inquisitive child is told that a big bird like the stork brings the little children, when the ancients have formed the phallus winged, when the popular designation of the sexual activity of man is expressed in German by the word "to bird" (*vögeln*), when the male member is directly called *l'uccello* (bird) by the Italians, all these facts are only small fragments from a large collection which teaches us that the wish to be able to fly signifies in the dream nothing more or less than the longing for the ability of sexual accomplishment. This is an early infantile wish. When the grown-up recalls his childhood it appears to him as a happy time in which one is happy for

the moment and looks to the future without any wishes, it is for this reason that he envies children. But if children themselves could inform us about it they would probably give different reports. It seems that childhood is not that blissful Idyl into which we later distort it, that on the contrary children are lashed through the years of childhood by the wish to become big, and to imitate the grown ups. This wish instigates all their playing. If in the course of their sexual investigation children feel that the grown up knows something wonderful in the mysterious and yet so important realm, what they are prohibited from knowing or doing, they are seized with a violent wish to know it, and dream of it in the form of flying, or prepare this disguise of the wish for their later flying dreams. Thus aviation, which has attained its aim in our times, has also its infantile erotic roots.

By admitting that he entertained a special personal relation to the problem of flying since his childhood, Leonardo bears out what we must assume from our investigation of children of our times, namely, that his childhood investigation was directed to sexual matters. At least this one problem escaped the repression which has later estranged him from sexuality. From childhood until the age of perfect intellectual maturity this subject, slightly varied, continued to hold his interest, and it is quite possible that he was as little successful in his cherished art in the primary sexual sense as in his desires for mechanical matters, that both wishes were denied to him.

As a matter of fact the great Leonardo remained infantile in some ways throughout his whole life; it is said that all great men retain something of the infantile. As a grown up he still continued playing, which sometimes made him appear strange and incomprehensible to his contemporaries. When he constructed the most artistic mechanical toys for court festivities and receptions we are dissatisfied thereby because we dislike to see the master waste his power on such petty stuff. He himself did not seem averse to giving his time to such things. Vasari reports that he did similar things even when not urged to it by request: "There (in Rome) he made a doughy mass out of wax, and when it softened he formed thereof very delicate animals filled with air; when he blew into them they flew in the air, and when the air was exhausted they fell to the ground. For a peculiar lizard caught by the wine-grower of Belvedere Leonardo made wings from skin pulled off from other lizards, which he filled with mercury so that they moved and trembled when it walked; he then made for it eyes, a beard and horns, tamed it and put it in a little box and terrified all his friends with it." Such playing often served him as an expression of serious thoughts: "He had often cleaned the intestines of a sheep so well that one could hold them in the hollow of the hand; he brought them into a big room, and

attached them to a blacksmith's bellows which he kept in an adjacent room, he then blew them up until they filled up the whole room so that everybody had to crowd into a corner. In this manner he showed how they gradually became transparent and filled up with air, and as they were at first limited to very little space and gradually became more and more extended in the big room, he compared them to a genius." His fables and riddles evince the same playful pleasure in harmless concealment and artistic investment, the riddles were put into the form of prophecies; almost all are rich in ideas and to a remarkable degree devoid of wit.

The plays and jumps which Leonardo allowed his phantasy have in some cases quite misled his biographers who misunderstood this part of his nature. In Leonardo's Milanese manuscripts one finds, for example, outlines of letters to the "Diodario of Sorio (Syria), viceroy of the holy Sultan of Babylon," in which Leonardo presents himself as an engineer sent to these regions of the Orient in order to construct some works. In these letters he defends himself against the reproach of laziness, he furnishes geographical descriptions of cities and mountains, and finally discusses a big elementary event which occurred while he was there.

In 1881, J. P. Richter had endeavored to prove from these documents that Leonardo made these traveler's observations when he really was in the service of the Sultan of Egypt, and that while in the Orient he embraced the Mohammedan religion. This sojourn in the Orient should have taken place in the time of 1483, that is, before he removed to the court of the Duke of Milan. However, it was not difficult for other authors to recognize the illustrations of this supposed journey to the Orient as what they really were, namely, phantastic productions of the youthful artist which he created for his own amusement, and in which he probably brought to expression his wishes to see the world and experience adventures.

A phantastic formation is probably also the "Accademia Vinciana," the acceptance of which is due to the existence of five or six most clever and intricate emblems with the inscription of the Academy. Vasari mentions these drawings but not the Academy. Müntz who placed such ornament on the cover of his big work on Leonardo belongs to the few who believe in the reality of an "Accademia Vinciana."

It is probable that this impulse to play disappeared in Leonardo's maturer years, that it became discharged in the investigating activity which signified the highest development of his personality. But the fact that it continued so long may teach us how slowly one tears himself away from his infantilism after having enjoyed in his childhood supreme erotic happiness which is later

unattainable.

VI

It would be futile to delude ourselves that at present, readers find every pathography unsavory. This attitude is excused with the reproach that from a pathographic elaboration of a great man one never obtains an understanding of his importance and his attainments, that it is therefore useless mischief to study in him things which could just as well be found in the first comer. However, this criticism is so clearly unjust that it can only be grasped when viewed as a pretext and a disguise for something. As a matter of fact pathography does not aim at making comprehensible the attainments of the great man; no one should really be blamed for not doing something which one never promised. The real motives for the opposition are quite different. One finds them when one bears in mind that biographers are fixed on their heroes in quite a peculiar manner. Frequently they take the hero as the object of study because, for reasons of their personal emotional life, they bear him a special affection from the very outset. They then devote themselves to a work of idealization which strives to enroll the great men among their infantile models, and to revive through him, as it were, the infantile conception of the father. For the sake of this wish they wipe out the individual features in his physiognomy, they rub out the traces of his life's struggle with inner and outer resistances, and do not tolerate in him anything of human weakness or imperfection; they then give us a cold, strange, ideal form instead of the man to whom we could feel distantly related. It is to be regretted that they do this, for they thereby sacrifice the truth to an illusion, and for the sake of their infantile phantasies they let slip the opportunity to penetrate into the most attractive secrets of human nature.

Leonardo himself, judging from his love for the truth and his inquisitiveness, would have interposed no objections to the effort of discovering the determinations of his psychic and intellectual development from the trivial peculiarities and riddles of his nature. We respect him by learning from him. It does no injury to his greatness to study the sacrifices which his development from the child must have entailed, and to the compile factors which have stamped on his person the tragic feature of failure.

Let us expressly emphasize that we have never considered Leonardo as a neurotic or as a "nervous person" in the sense of this awkward term. Whoever takes it amiss that we should even dare apply to him viewpoints gained from pathology, still clings to prejudices which we have at present justly given up. We

no longer believe that health and disease, normal and nervous, are sharply distinguished from each other, and that neurotic traits must be judged as proof of general inferiority. We know to-day that neurotic symptoms are substitutive formations for certain repressive acts which have to be brought about in the course of our development from the child to the cultural man, that we all produce such substitutive formations, and that only the amount, intensity, and distribution of these substitutive formations justify the practical conception of illness and the conclusion of constitutional inferiority. Following the slight signs in Leonardo's personality we would place him near that neurotic type which we designate as the "compulsive type," and we would compare his investigation with the "reasoning mania" of neurotics, and his inhibitions with the so-called "abulias" of the latter.

The object of our work was to explain the inhibitions in Leonardo's sexual life and in his artistic activity. For this purpose we shall now sum up what we could discover concerning the course of his psychic development.

We were unable to gain any knowledge about his hereditary factors, on the other hand we recognize that the accidental circumstances of his childhood produced a far reaching disturbing effect. His illegitimate birth deprived him of the influence of a father until perhaps his fifth year, and left him to the tender seduction of a mother whose only consolation he was. Having been kissed by her into sexual prematurity, he surely must have entered into a phase of infantile sexual activity of which only one single manifestation was definitely evinced, namely, the intensity of his infantile sexual investigation. The impulse for looking and inquisitiveness were most strongly stimulated by his impressions from early childhood; the enormous mouth-zone received its accentuation which it had never given up. From his later contrasting behavior, as the exaggerated sympathy for animals, we can conclude that this infantile period did not lack in strong sadistic traits.

An energetic shift of repression put an end to this infantile excess, and established the dispositions which became manifest in the years of puberty. The most striking result of this transformation was a turning away from all gross sensual activities. Leonardo was able to lead a life of abstinence and made the impression of an asexual person. When the floods of pubescent excitement came over the boy they did not make him ill by forcing him to costly and harmful substitutive formations; owing to the early preference for sexual inquisitiveness, the greater part of the sexual needs could be sublimated into a general thirst after knowledge and so elude repression. A much smaller portion of the libido was applied to sexual aims, and represented the stunted sexual life of the grown up. In consequence of the repression of the love for the mother this portion assumed

a homosexual attitude and manifested itself as ideal love for boys. The fixation on the mother, as well as the happy reminiscences of his relations with her, was preserved in his unconscious but remained for the time in an inactive state. In this manner the repression, fixation, and sublimation participated in the disposal of the contributions which the sexual impulse furnished to Leonardo's psychic life.

From the obscure age of boyhood Leonardo appears to us as an artist, a painter, and sculptor, thanks to a specific talent which was probably enforced by the early awakening of the impulse for looking in the first years of childhood. We would gladly report in what way the artistic activity depends on the psychic primitive forces were it not that our material is inadequate just here. We content ourselves by emphasizing the fact, concerning which hardly any doubt still exists, that the productions of the artist give outlet also to his sexual desire, and in the case of Leonardo we can refer to the information imparted by Vasari, namely, that heads of laughing women and pretty boys, or representations of his sexual objects, attracted attention among his first artistic attempts. It seems that during his flourishing youth Leonardo at first worked in an uninhibited manner. As he took his father as a model for his outer conduct in life, he passed through a period of manly creative power and artistic productivity in Milan, where favored by fate he found a substitute for his father in the duke Lodovico Moro. But the experience of others was soon confirmed in him, to wit, that the almost complete suppression of the real sexual life does not furnish the most favorable conditions for the activity of the sublimated sexual strivings. The figurativeness of his sexual life asserted itself, his activity and ability to quick decisions began to weaken, the tendency to reflection and delay was already noticeable as a disturbance in *The Holy Supper*, and with the influence of the technique determined the fate of this magnificent work. Slowly a process developed in him which can be put parallel only to the regressions of neurotics. His development at puberty into the artist was outstripped by the early infantile determinant of the investigator, the second sublimation of his erotic impulses turned back to the primitive one which was prepared at the first repression. He became an investigator, first in service of his art, later independently and away from his art. With the loss of his patron, the substitute for his father, and with the increasing difficulties in his life, the regressive displacement extended in dimension. He became "*impacientissimo al pennello*" (most impatient with the brush) as reported by a correspondent of the countess Isabella d'Este who desired to possess at any cost a painting from his hand. His infantile past had obtained control over him. The investigation, however, which now took the place of his artistic production, seems to have born certain traits which betrayed the activity

of unconscious impulses; this was seen in his insatiability, his regardless obstinacy, and in his lack of ability to adjust himself to actual conditions.

At the summit of his life, in the age of the first fifties, at a time when the sex characteristics of the woman have already undergone a regressive change, and when the libido in the man not infrequently ventures into an energetic advance, a new transformation came over him. Still deeper strata of his psychic content became active again, but this further regression was of benefit to his art which was in a state of deterioration. He met the woman who awakened in him the memory of the happy and sensuously enraptured smile of his mother, and under the influence of this awakening he acquired back the stimulus which guided him in the beginning of his artistic efforts when he formed the smiling woman. He painted Monna Lisa, Saint Anne, and a number of mystic pictures which were characterized by the enigmatic smile. With the help of his oldest erotic feelings he triumphed in conquering once more the inhibition in his art. This last development faded away in the obscurity of the approaching old age. But before this his intellect rose to the highest capacity of a view of life, which was far in advance of his time.

In the preceding chapters I have shown what justification one may have for such representation of Leonardo's course of development, for this manner of arranging his life and explaining his wavering between art and science. If after accomplishing these things I should provoke the criticism from even friends and adepts of psychoanalysis, that I have only written a psychoanalytic romance, I should answer that I certainly did not overestimate the reliability of these results. Like others I succumbed to the attraction emanating from this great and mysterious man, in whose being one seems to feel powerful propelling passions, which after all can only evince themselves so remarkably subdued.

But whatever may be the truth about Leonardo's life we cannot relinquish our effort to investigate it psychoanalytically before we have finished another task. In general we must mark out the limits which are set up for the working capacity of psychoanalysis in biography so that every omitted explanation should not be held up to us as a failure. Psychoanalytic investigation has at its disposal the data of the history of the person's life, which on the one hand consists of accidental events and environmental influences, and on the other hand of the reported reactions of the individual. Based on the knowledge of psychic mechanisms it now seeks to investigate dynamically the character of the individual from his reactions, and to lay bare his earliest psychic motive forces as well as their later transformations and developments. If this succeeds then the reaction of the personality is explained through the coöperation of constitutional and accidental factors or through inner and outer forces. If such an undertaking, as perhaps in

the case of Leonardo, does not yield definite results then the blame for it is not to be laid to the faulty or inadequate psychoanalytic method, but to the vague and fragmentary material left by tradition about this person. It is, therefore, only the author who forced psychoanalysis to furnish an expert opinion on such insufficient material, who is to be held responsible for the failure.

However, even if one had at his disposal a very rich historical material and could manage the psychic mechanism with the greatest certainty, a psychoanalytic investigation could not possibly furnish the definite view, if it concerns two important questions, that the individual could turn out only so and not differently. Concerning Leonardo we had to represent the view that the accident of his illegitimate birth and the pampering of his mother exerted the most decisive influence on his character formation and his later fate, through the fact that the sexual repression following this infantile phase caused him to sublimate his libido into a thirst after knowledge, and thus determined his sexual inactivity for his entire later life. The repression, however, which followed the first erotic gratification of childhood did not have to take place, in another individual it would perhaps not have taken place or it would have turned out not nearly as profuse. We must recognize here a degree of freedom which can no longer be solved psychoanalytically. One is as little justified in representing the issue of this shift of repression as the only possible issue. It is quite probable that another person would not have succeeded in withdrawing the main part of his libido from the repression through sublimation into a desire for knowledge; under the same influences as Leonardo another person might have sustained a permanent injury to his intellectual work or an uncontrollable disposition to compulsion neurosis. The two characteristics of Leonardo which remained unexplained through psychoanalytic effort are first, his particular tendency to repress his impulses, and second, his extraordinary ability to sublimate the primitive impulses.

The impulses and their transformations are the last things that psychoanalysis can discern. Henceforth it leaves the place to biological investigation. The tendency to repression, as well as the ability to sublimate, must be traced back to the organic bases of the character, upon which alone the psychic structure springs up. As artistic talent and productive ability are intimately connected with sublimation we have to admit that also the nature of artistic attainment is psychoanalytically inaccessible to us. Biological investigation of our time endeavors to explain the chief traits of the organic constitution of a person through the fusion of male and female predispositions in the material sense; Leonardo's physical beauty as well as his left-handedness furnish here some support. However, we do not wish to leave the ground of pure psychologic

investigation. Our aim remains to demonstrate the connection between outer experiences and reactions of the person over the path of the activity of the impulses. Even if psychoanalysis does not explain to us the fact of Leonardo's artistic accomplishment, it still gives us an understanding of the expressions and limitations of the same. It does seem as if only a man with Leonardo's childhood experiences could have painted Monna Lisa and Saint Anne, and could have supplied his works with that sad fate and so obtain unheard of fame as a natural historian; it seems as if the key to all his attainments and failures was hidden in the childhood phantasy of the vulture.

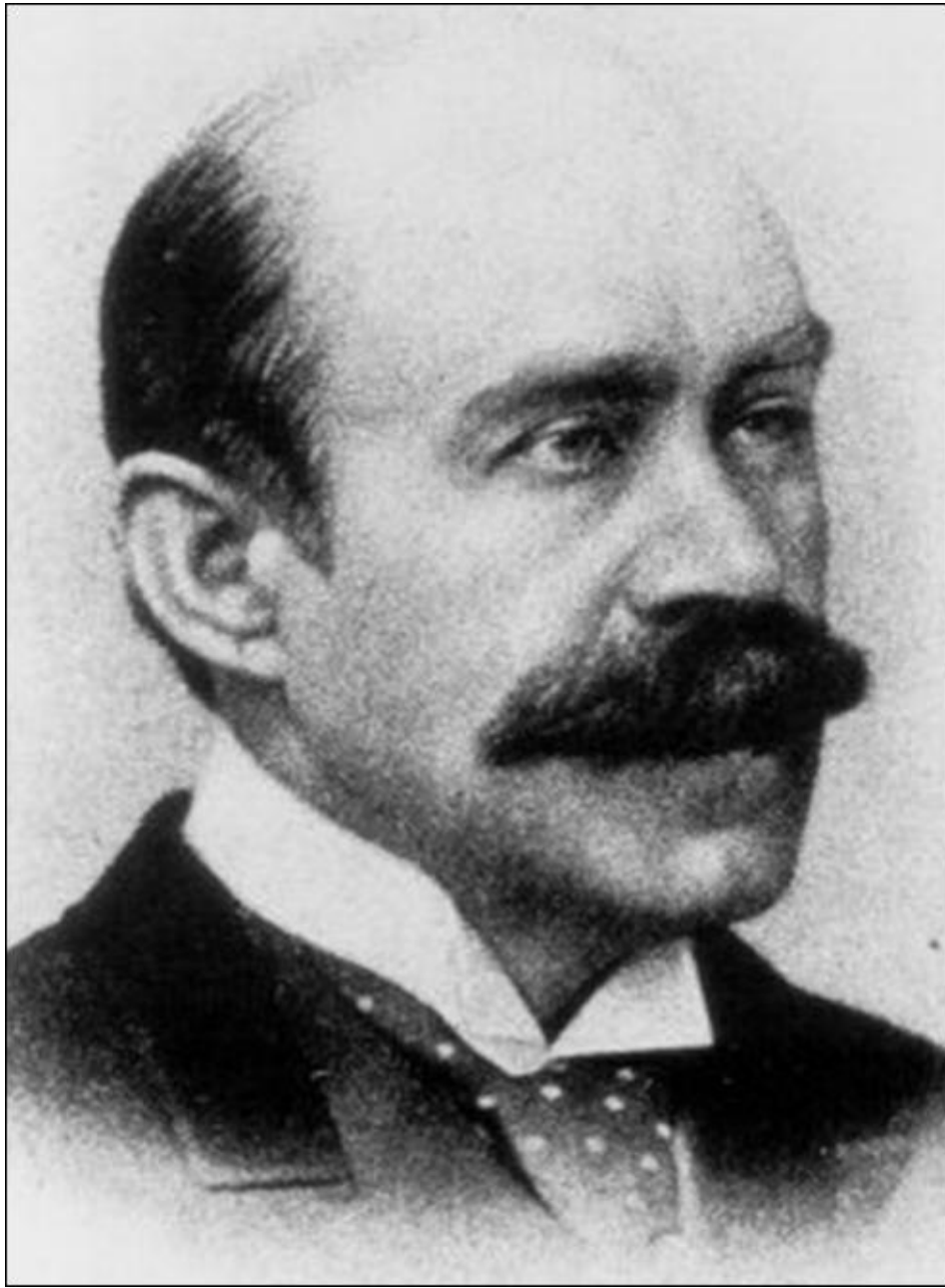
But may one not take offense at the results of an investigation which concede to the accidents of the parental constellation so decisive an influence on the fate of a person, which, for example, subordinates Leonardo's fate to his illegitimate birth and to the sterility of his first step-mother Donna Albiera? I believe that one has no right to feel so; if one considers accident as unworthy of determining our fate, it is only a relapse to the pious aspect of life, the overcoming of which Leonardo himself prepared when he put down in writing that the sun does not move. We are naturally grieved over the fact that a just God and a kindly providence do not guard us better against such influences in our most defenseless age. We thereby gladly forget that as a matter of fact everything in our life is accident from our very origin through the meeting of spermatozoa and ovum, accident, which nevertheless participates in the lawfulness and fatalities of nature, and lacks only the connection to our wishes and illusions. The division of life's determinants into the "fatalities" of our constitution and the "accidents" of our childhood may still be indefinite in individual cases, but taken altogether one can no longer entertain any doubt about the importance of precisely our first years of childhood. We all still show too little respect for nature, which in Leonardo's deep words recalling Hamlet's speech "*is full of infinite reasons which never appeared in experience.*" Every one of us human beings corresponds to one of the infinite experiments in which these "reasons of nature" force themselves into experience.

THE END

Extract from 'THE RENAISSANCE' by Walter Pater



Walter Horatio Pater (1839-1894) was an English essayist, critic of art and literature and a writer of fiction. This essay was taken from his critical work *The Renaissance*, first published in the *Fortnightly Review* in 1869.



Walter Pater

LEONARDO DA VINCI

HOMO MINISTER ET INTERPRES NATURAE

In Vasari's life of Leonardo da Vinci as we now read it there are some variations from the first edition. There, the painter who has fixed the outward type of Christ for succeeding centuries was a bold speculator, holding lightly by other men's beliefs, setting philosophy above Christianity. Words of his, trenchant enough to justify this impression, are not recorded, and would have been out of keeping with a genius of which one characteristic is the tendency to lose itself in a refined and graceful mystery. The suspicion was but the time-honoured mode in which the world stamps its appreciation of one who has thoughts for himself alone, his high indifference, his intolerance of the common forms of things; and in the second edition the image was changed into something fainter and more conventional. But it is still by a certain mystery in his work, and something enigmatical beyond the usual measure of great men, that he fascinates, or perhaps half repels. His life is one of sudden revolts, with intervals in which he works not at all, or apart from the main scope of his work. By a strange fortune the works on which his more popular fame rested disappeared early from the world, as the Battle of the Standard; or are mixed obscurely with the work of meaner hands, as the Last Supper. His type of beauty is so exotic that it fascinates a larger number than it delights, and seems more than that of any other artist to reflect ideas and views and some scheme of the world within; so that he seemed to his contemporaries to be the possessor of some unsanctified and sacred wisdom; as to Michelet and others to have anticipated modern ideas. He trifles with his genius, and crowds all his chief work into a few tormented years of later life; yet he is so possessed by his genius that he passes unmoved through the most tragic events, overwhelming his country and friends, like one who comes across them by chance on some secret errand.

His legend, as the French say, with the anecdotes which every one knows, is one of the most brilliant in Vasari. Later writers merely copied it, until, in 1804, Carlo Amoretti applied to it a criticism which left hardly a date fixed, and not one of those anecdotes untouched. The various questions thus raised have since that time become, one after another, subjects of special study, and mere antiquarianism has in this direction little more to do. For others remain the editing of the thirteen books of his manuscripts, and the separation by technical

criticism of what in his reputed works is really his, from what is only half his, or the work of his pupils. But a lover of strange souls may still analyse for himself the impression made on him by those works, and try to reach through it a definition of the chief elements of Leonardo's genius. The legend, corrected and enlarged by its critics, may now and then intervene to support the results of this analysis.

His life has three divisions — thirty years at Florence, nearly twenty years at Milan, then nineteen years of wandering, till he sinks to rest under the protection of Francis the First at the Chateau de Clou. The dishonour of illegitimacy hangs over his birth. Piero Antonio, his father, was of a noble Florentine house, of Vinci in the Val d'Arno, and Leonardo, brought up delicately among the true children of that house, was the love-child of his youth, with the keen, puissant nature such children often have. We see him in his youth fascinating all men by his beauty, improvising music and songs, buying the caged birds and setting them free, as he walked the streets of Florence, fond of odd bright dresses and spirited horses.

From his earliest years he designed many objects, and constructed models in relief, of which Vasari mentions some of women smiling. His father, pondering over this promise in the child, took him to the workshop of Andrea del Verrocchio, then the most famous artist in Florence. Beautiful objects lay about there — reliquaries, pyxes, silver images for the pope's chapel at Rome, strange fancy-work of the middle age, keeping odd company with fragments of antiquity, then but lately discovered. Another student Leonardo may have seen there — a boy into whose soul the level light and aerial illusions of Italian sunsets had passed, in after days famous as Perugino. Verrocchio was an artist of the earlier Florentine type, carver, painter, and worker in metals, in one; designer, not of pictures only, but of all things for sacred or household use, drinking-vessels, ambries, instruments of music, making them all fair to look upon, filling the common ways of life with the reflexion of some far-off brightness; and years of patience had refined his hand till his work was now sought after from distant places.

It happened that Verrocchio was employed by the brethren of Vallombrosa to paint the Baptism of Christ, and Leonardo was allowed to finish an angel in the left hand corner. It was one of those moments in which the progress of a great thing — here, that of the art of Italy — presses hard and sharp on the happiness of an individual, through whose discouragement and decrease, humanity, in more fortunate persons, comes a step nearer to its final success.

For beneath the cheerful exterior of the mere well-paid craftsman, chasing brooches for the copes of Santa Maria Novella, or twisting metal screens for the

tombs of the Medici, lay the ambitious desire of expanding the destiny of Italian art by a larger knowledge and insight into things, a purpose in art not unlike Leonardo's still unconscious purpose; and often, in the modelling of drapery, or of a lifted arm, or of hair cast back from the face, there came to him something of the freer manner and richer humanity of a later age. But in this Baptism the pupil had surpassed the master; and Verrocchio turned away as one stunned, and as if his sweet earlier work must thereafter be distasteful to him, from the bright animated angel of Leonardo's hand.

The angel may still be seen in Florence, a space of sunlight in the cold, laboured old picture; but the legend is true only in sentiment, for painting had always been the art by which Verrocchio set least store. And as in a sense he anticipates Leonardo, so to the last Leonardo recalls the studio of Verrocchio, in the love of beautiful toys, such as the vessel of water for a mirror, and lovely needle-work about the implicated hands in the Modesty and Vanity, and of reliefs like those cameos which in the Virgin of the Balances hang all round the girdle of Saint Michael, and of bright variegated stones, such as the agates in the Saint Anne, and in a hieratic preciseness and grace, as of a sanctuary swept and garnished. Amid all the cunning and intricacy of his Lombard manner this never left him. Much of it there must have been in that lost picture of Paradise, which he prepared as a cartoon for tapestry, to be woven in the looms of Flanders. It was the perfection of the older Florentine style of miniature-painting, with patient putting of each leaf upon the trees and each flower in the grass, where the first man and woman were standing.

And because it was the perfection of that style, it awoke in Leonardo some seed of discontent which lay in the secret places of his nature. For the way to perfection is through a series of disgusts; and this picture — all that he had done so far in his life at Florence — was after all in the old slight manner. His art, if it was to be something in the world, must be weighted with more of the meaning of nature and purpose of humanity. Nature was "the true mistress of higher intelligences." So he plunged into the study of nature. And in doing this he followed the manner of the older students; he brooded over the hidden virtues of plants and crystals, the lines traced by the stars as they moved in the sky, over the correspondences which exist between the different orders of living things, through which, to eyes opened, they interpret each other; and for years he seemed to those about him as one listening to a voice, silent for other men.

He learned here the art of going deep, of tracking the sources of expression to their subtlest retreats, the power of an intimate presence in the things he handled. He did not at once or entirely desert his art; only he was no longer the cheerful, objective painter, through whose soul, as through clear glass, the bright figures

of Florentine life, only made a little mellowed and more pensive by the transit, passed on to the white wall. He wasted many days in curious tricks of design, seeming to lose himself in the spinning of intricate devices of lines and colours. He was smitten with a love of the impossible — the perforation of mountains, changing the course of rivers, raising great buildings, such as the church of San Giovanni, in the air; all those feats for the performance of which natural magic professed to have the key. Later writers, indeed, see in these efforts an anticipation of modern mechanics; in him they were rather dreams, thrown off by the overwrought and labouring brain. Two ideas were especially fixed in him, as reflexes of things that had touched his brain in childhood beyond the measure of other impressions — the smiling of women and the motion of great waters.

And in such studies some interfusion of the extremes of beauty and terror shaped itself, as an image that might be seen and touched, in the mind of this gracious youth, so fixed that for the rest of his life it never left him; and as catching glimpses of it in the strange eyes or hair of chance people, he would follow such about the streets of Florence till the sun went down, of whom many sketches of his remain. Some of these are full of a curious beauty, that remote beauty apprehended only by those who have sought it carefully; who, starting with acknowledged types of beauty, have refined as far upon these, as these refine upon the world of common forms. But mingled inextricably with this there is an element of mockery also; so that, whether in sorrow or scorn, he caricatures Dante even. Legions of grotesques sweep under his hand; for has not nature too her grotesques — the rent rock, the distorting light of evening on lonely roads, the unveiled structure of man in the embryo, or the skeleton?

All these swarming fancies unite in the Medusa of the Uffizii. Vasari's story of an earlier Medusa, painted on a wooden shield, is perhaps an invention; and yet, properly told, has more of the air of truth about it than anything else in the whole legend. For its real subject is not the serious work of a man, but the experiment of a child. The lizards and glow-worms and other strange small creatures which haunt an Italian vineyard bring before one the whole picture of a child's life in a Tuscan dwelling — half castle, half farm — and are as true to nature as the pretended astonishment of the father for whom the boy has prepared a surprise. It was not in play that he painted that other Medusa, the one great picture which he left behind him in Florence. The subject has been treated in various ways; Leonardo alone cuts to its centre; he alone realises it as the head of a corpse, exercising its powers through all the circumstances of death. What may be called the fascination of corruption penetrates in every touch its exquisitely finished beauty. About the dainty lines of the cheek the bat flits unheeded. The delicate snakes seem literally strangling each other in terrified

struggle to escape from the Medusa brain. The hue which violent death always brings with it is in the features: features singularly massive and grand, as we catch them inverted, in a dexterous foreshortening, sloping upwards, almost sliding down upon us, crown foremost, like a great calm stone against which the wave of serpents breaks. But it is a subject that may well be left to the beautiful verses of Shelley.

The science of that age was all divination, clairvoyance, unsubjected to our exact modern formulas, seeking in an instant of vision to concentrate a thousand experiences. Later writers, thinking only of the well-ordered treatise on painting which a Frenchman, Raffaello du Fresne, a hundred years afterwards, compiled from Leonardo's bewildered manuscripts, written strangely, as his manner was, from right to left, have imagined a rigid order in his inquiries. But this rigid order was little in accordance with the restlessness of his character; and if we think of him as the mere reasoner who subjects design to anatomy, and composition to mathematical rules, we shall hardly have of him that impression which those about him received from him. Poring over his crucibles, making experiments with colour, trying, by a strange variation of the alchemist's dream, to discover the secret, not of an elixir to make man's natural life immortal, but rather of giving immortality to the subtlest and most delicate effects of painting, he seemed to them rather the sorcerer or the magician, possessed of curious secrets and a hidden knowledge, living in a world of which he alone possessed the key. What his philosophy seems to have been most like is that of Paracelsus or Cardan; and much of the spirit of the older alchemy still hangs about it, with its confidence in short cuts and odd byways to knowledge. To him philosophy was to be something giving strange swiftness and double sight, divining the sources of springs beneath the earth or of expression beneath the human countenance, clairvoyant of occult gifts in common or uncommon things, in the reed at the brook-side, or the star which draws near to us but once in a century. How, in this way, the clear purpose was overclouded, the fine chaser's hand perplexed, we but dimly see; the mystery which at no point quite lifts from Leonardo's life is deepest here. But it is certain that at one period of his life he had almost ceased to be an artist.

The year 1483 — the year of the birth of Raffaello and the thirty-first of Leonardo's life — is fixed as the date of his visit to Milan by the letter in which he recommends himself to Ludovico Sforza, and offers to tell him, for a price, strange secrets in the art of war. It was that Sforza who murdered his young nephew by slow poison, yet was so susceptible of religious impressions that he blended mere earthly passions with a sort of religious sentimentalism, and who took for his device the mulberry-tree — symbol, in its long delay and sudden

yielding of flowers and fruit together, of a wisdom which economises all forces for an opportunity of sudden and sure effect. The fame of Leonardo had gone before him, and he was to model a colossal statue of Francesco, the first Duke of Milan. As for Leonardo himself, he came not as an artist at all, or careful of the fame of one; but as a player on the harp, a strange harp of silver of his own construction, shaped in some curious likeness to a horse's skull. The capricious spirit of Ludovico was susceptible also of the charm of music, and Leonardo's nature had a kind of spell in it. Fascination is always the word descriptive of him. No portrait of his youth remains; but all tends to make us believe that up to this time some charm of voice and aspect, strong enough to balance the disadvantage of his birth, had played about him. His physical strength was great; it was said that he could bend a horse-shoe like a coil of lead.

The Duomo, the work of artists from beyond the Alps, so fantastic to the eye of a Florentine used to the mellow, unbroken surfaces of Giotto and Arnolfo, was then in all its freshness; and below, in the streets of Milan, moved a people as fantastic, changeful and dreamlike. To Leonardo least of all men could there be anything poisonous in the exotic flowers of sentiment which grew there. It was a life of brilliant sins and exquisite amusements: Leonardo became a celebrated designer of pageants: and it suited the quality of his genius, composed in almost equal parts of curiosity and the desire of beauty, to take things as they came.

Curiosity and the desire of beauty — these are the two elementary forces in Leonardo's genius; curiosity often in conflict with the desire of beauty, but generating, in union with it, a type of subtle and curious grace.

The movement of the fifteenth century was twofold; partly the Renaissance, partly also the coming of what is called the "modern spirit," with its realism, its appeal to experience: it comprehended a return to antiquity, and a return to nature. Raffaello represents the return to antiquity, and Leonardo the return to nature. In this return to nature, he was seeking to satisfy a boundless curiosity by her perpetual surprises, a microscopic sense of finish by her finesse, or delicacy of operation, that *subtilitas naturae* which Bacon notices. So we find him often in intimate relations with men of science, — with Fra Luca Paccioli the mathematician, and the anatomist Marc Antonio della Torre. His observations and experiments fill thirteen volumes of manuscript; and those who can judge describe him as anticipating long before, by rapid intuition, the later ideas of science. He explained the obscure light of the unilluminated part of the moon, knew that the sea had once covered the mountains which contain shells, and the gathering of the equatorial waters above the polar.

He who thus penetrated into the most secret parts of nature preferred always

the more to the less remote, what, seeming exceptional, was an instance of law more refined, the construction about things of a peculiar atmosphere and mixed lights. He paints flowers with such curious felicity that different writers have attributed to him a fondness for particular flowers, as Clement the cyclamen, and Rio the jasmin; while, at Venice, there is a stray leaf from his portfolio dotted all over with studies of violets and the wild rose. In him first appears the taste for what is bizarre or *recherche* in landscape; hollow places full of the green shadow of bituminous rocks, ridged reefs of trap-rock which cut the water into quaint sheets of light — their exact antitype is in our own western seas; all the solemn effects of moving water; you may follow it springing from its distant source among the rocks on the heath of the Madonna of the Balances, passing, as a little fall, into the treacherous calm of the Madonna of the Lake, next, as a goodly river, below the cliffs of the Madonna of the Rocks, washing the white walls of its distant villages, stealing out in a network of divided streams in La Gioconda to the seashore of the Saint Anne — that delicate place, where the wind passes like the hand of some fine etcher over the surface, and the untorn shells are lying thick upon the sand, and the tops of the rocks, to which the waves never rise, are green with grass, grown fine as hair. It is the landscape, not of dreams or of fancy, but of places far withdrawn, and hours selected from a thousand with a miracle of finesse. Through Leonardo's strange veil of sight things reach him so; in no ordinary night or day, but as in faint light of eclipse, or in some brief interval of falling rain at daybreak, or through deep water.

And not into nature only; but he plunged also into human personality, and became above all a painter of portraits; faces of a modelling more skilful than has been seen before or since, embodied with a reality which almost amounts to illusion, on dark air. To take a character as it was, and delicately sound its stops, suited one so curious in observation, curious in invention. So he painted the portraits of Ludovico's mistresses, Lucretia Crivelli and Cecilia Galerani the poetess, of Ludovico himself, and the Duchess Beatrice. The portrait of Cecilia Galerani is lost; but that of Lucretia Crivelli has been identified with La Belle Feroniere of the Louvre, and Ludovico's pale, anxious face still remains in the Ambrosian library. Opposite is the portrait of Beatrice d'Este, in whom Leonardo seems to have caught some presentiment of early death, painting her precise and grave, full of the refinement of the dead, in sad earth-coloured raiment, set with pale stones.

Sometimes this curiosity came in conflict with the desire of beauty; it tended to make him go too far below that outside of things in which art begins and ends. This struggle between the reason and its ideas, and the senses, the desire of beauty, is the key to Leonardo's life at Milan — his restlessness, his endless

retouchings, his odd experiments with colour. How much must he leave unfinished, how much recommence! His problem was the transmutation of ideas into images. What he had attained so far had been the mastery of that earlier Florentine style, with its naive and limited sensuousness. Now he was to entertain in this narrow medium those divinations of a humanity too wide for it, that larger vision of the opening world, which is only not too much for the great, irregular art of Shakspeare; and everywhere the effort is visible in the work of his hands. This agitation, this perpetual delay, give him an air of weariness and ennui. To others he seems to be aiming at an impossible effect, to do something that art, that painting, can never do. Often the expression of physical beauty at this or that point seems strained and marred in the effort, as in those heavy German foreheads — too German and heavy for perfect beauty.

For there was a touch of Germany in that genius which, as Goethe said, had “thought itself weary” — *muede sich gedacht*. What an anticipation of modern Germany, for instance, in that debate on the question whether sculpture or painting is the nobler art.* But there is this difference between him and the German, that, with all that curious science, the German would have thought nothing more was needed; and the name of Goethe himself reminds one how great for the artist may be the danger of overmuch science; how Goethe, who, in the *Elective Affinities* and the first part of *Faust*, does transmute ideas into images, who wrought many such transmutations, did not invariably find the spell-word, and in the second part of *Faust* presents us with a mass of science which has almost no artistic character at all. But Leonardo will never work till the happy moment comes — that moment of *bien-etre*, which to imaginative men is a moment of invention. On this moment he waits; other moments are but a preparation, or after-taste of it. Few men distinguish between them as jealously as he did. Hence so many flaws even in the choicest work. But for Leonardo the distinction is absolute, and, in the moment of *bien-etre*, the alchemy complete: the idea is stricken into colour and imagery: a cloudy mysticism is refined to a subdued and graceful mystery, and painting pleases the eye while it satisfies the soul.

*How princely, how characteristic of Leonardo, the answer, *Quanto piu, un'arte porta seco fatica di corpo, tanto piu e vile!*

This curious beauty is seen above all in his drawings, and in these chiefly in the abstract grace of the bounding lines. Let us take some of these drawings, and pause over them awhile; and, first, one of those at Florence — the heads of a woman and a little child, set side by side, but each in its own separate frame. First of all, there is much pathos in the reappearance in the fuller curves of the face of the child, of the sharper, more chastened lines of the worn and older face,

which leaves no doubt that the heads are those of a little child and its mother. A feeling for maternity is indeed always characteristic of Leonardo; and this feeling is further indicated here by the half-humorous pathos of the diminutive, rounded shoulders of the child. You may note a like pathetic power in drawings of a young man seated in a stooping posture, his face in his hands, as in sorrow; of a slave sitting in an uneasy inclined posture, in some brief interval of rest; of a small Madonna and Child, peeping sideways in half-reassured terror, as a mighty griffin with batlike wings, one of Leonardo's finest inventions, descends suddenly from the air to snatch up a lion wandering near them. But note in these, as that which especially belongs to art, the contour of the young man's hair, the poise of the slave's arm above his head, and the curves of the head of the child, following the little skull within, thin and fine as some seashell worn by the wind.

Take again another head, still more full of sentiment, but of a different kind, a little drawing in red chalk which every one remembers who has examined at all carefully the drawings by old masters at the Louvre. It is a face of doubtful sex, set in the shadow of its own hair, the cheek-line in high light against it, with something voluptuous and full in the eyelids and the lips. Another drawing might pass for the same face in childhood, with parched and feverish lips, but with much sweetness in the loose, short-waisted childish dress, with necklace and bulla, and in the daintily bound hair. We might take the thread of suggestion which these two drawings offer, when thus set side by side, and, following it through the drawings at Florence, Venice, and Milan, construct a sort of series, illustrating better than anything else Leonardo's type of womanly beauty. Daughters of Herodias, with their fantastic head-dresses knotted and folded so strangely to leave the dainty oval of the face disengaged, they are not of the Christian family, or of Raffaello's. They are the clairvoyants, through whom, as through delicate instruments, one becomes aware of the subtler forces of nature, and the modes of their action, all that is magnetic in it, all those finer conditions wherein material things rise to that subtlety of operation which constitutes them spiritual, where only the finer nerve and the keener touch can follow: it is as if in certain revealing instances we actually saw them at their work on human flesh. Nervous, electric, faint always with some inexplicable faintness, they seem to be subject to exceptional conditions, to feel powers at work in the common air unfelt by others, to become, as it were, receptacles of them, and pass them on to us in a chain of secret influences.

But among the more youthful heads there is one at Florence which Love chooses for its own — the head of a young man, which may well be the likeness of Andrea Salaino, beloved of Leonardo for his curled and waving hair — *belli capelli ricci e inanellati* — and afterwards his favourite pupil and servant. Of all

the interests in living men and women which may have filled his life at Milan, this attachment alone is recorded; and in return Salaino identified himself so entirely with Leonardo, that the picture of Saint Anne, in the Louvre, has been attributed to him. It illustrates Leonardo's usual choice of pupils, men of some natural charm of person or intercourse like Salaino, or men of birth and princely habits of life like Francesco Melzi — men with just enough genius to be capable of initiation into his secret, for the sake of which they were ready to efface their own individuality. Among them, retiring often to the Villa of the Melzi at Canonica al Vaprio, he worked at his fugitive manuscripts and sketches, working for the present hour, and for a few only, perhaps chiefly for himself. Other artists have been as careless of present or future applause, in self-forgetfulness, or because they set moral or political ends above the ends of art; but in him this solitary culture of beauty seems to have hung upon a kind of self-love, and a carelessness in the work of art of all but art itself. Out of the secret places of a unique temperament he brought strange blossoms and fruits hitherto unknown; and for him, the novel impression conveyed, the exquisite effect woven, counted as an end in itself — a perfect end.

And these pupils of his acquired his manner so thoroughly, that though the number of Leonardo's authentic works is very small indeed, there is a multitude of other men's pictures through which we undoubtedly see him, and come very near to his genius. Sometimes, as in the little picture of the Madonna of the Balances, in which, from the bosom of His mother, Christ weighs the pebbles of the brooks against the sins of men, we have a hand, rough enough by contrast, working upon some fine hint or sketch of his. Sometimes, as in the subjects of the Daughter of Herodias and the Head of John the Baptist, the lost originals have been re-echoed and varied upon again and again by Luini and others. At other times the original remains, but has been a mere theme or motive, a type of which the accessories might be modified or changed; and these variations have but brought out the more the purpose, or expression of the original. It is so with the so-called Saint John the Baptist of the Louvre — one of the few naked figures Leonardo painted — whose delicate brown flesh and woman's hair no one would go out into the wilderness to seek, and whose treacherous smile would have us understand something far beyond the outward gesture or circumstance. But the long, reedlike cross in the hand, which suggests Saint John the Baptist, becomes faint in a copy at the Ambrosian Library, and disappears altogether in another, in the Palazzo Rosso at Genoa. Returning from the last to the original, we are no longer surprised by Saint John's strange likeness to the Bacchus which hangs near it, which set Theophile Gautier thinking of Heine's notion of decayed gods, who, to maintain themselves, after the fall of paganism,

took employment in the new religion. We recognise one of those symbolical inventions in which the ostensible subject is used, not as matter for definite pictorial realisation, but as the starting-point of a train of sentiment as subtle and vague as a piece of music. No one ever ruled over his subject more entirely than Leonardo, or bent it more dexterously to purely artistic ends. And so it comes to pass that though he handles sacred subjects continually, he is the most profane of painters; the given person or subject, Saint John in the Desert, or the Virgin on the knees of Saint Anne, is often merely the pretext for a kind of work which carries one quite out of the range of its conventional associations.

About the Last Supper, its decay and restorations, a whole literature has risen up, Goethe's pensive sketch of its sad fortunes being far the best. The death in childbirth of the Duchess Beatrice was followed in Ludovico by one of those paroxysms of religious feeling which in him were constitutional. The low, gloomy Dominican church of Saint Mary of the Graces had been the favourite shrine of Beatrice. She had spent her last days there, full of sinister presentiments; at last it had been almost necessary to remove her from it by force; and now it was here that mass was said a hundred times a day for her repose. On the damp wall of the refectory, oozing with mineral salts, Leonardo painted the Last Supper. A hundred anecdotes were told about it, his retouchings and delays. They show him refusing to work except at the moment of invention, scornful of whoever thought that art was a work of mere industry and rule, often coming the whole length of Milan to give a single touch. He painted it, not in fresco, where all must be impromptu, but in oils, the new method which he had been one of the first to welcome, because it allowed of so many afterthoughts, so refined a working out of perfection. It turned out that on a plastered wall no process could have been less durable. Within fifty years it had fallen into decay. And now we have to turn back to Leonardo's own studies, above all to one drawing of the central head at the Brera, which, in a union of tenderness and severity in the face-lines, reminds one of the monumental work of Mino da Fiesole, to trace it as it was.

It was another effort to lift a given subject out of the range of its conventional associations. Strange, after all the misrepresentations of the middle age, was the effort to see it, not as the pale Host of the altar, but as one taking leave of his friends. Five years afterwards the young Raffaello, at Florence, painted it with sweet and solemn effect in the refectory of Saint Onofrio; but still with all the mystical unreality of the school of Perugino. Vasari pretends that the central head was never finished; but finished or unfinished, or owing part of its effect to a mellowing decay, this central head does but consummate the sentiment of the whole company — ghosts through which you see the wall, faint as the shadows

of the leaves upon the wall, on autumn afternoons; this figure is but the faintest, most spectral of them all. It is the image of what the history it symbolises has more and more become for the world, paler and paler as it recedes into the distance. Criticism came with its appeal from mystical unrealities to originals, and restored no lifelike reality but these transparent shadows, spirits which have not flesh and bones.

The Last Supper was finished in 1497; in 1498 the French entered Milan, and whether or not the Gascon bowmen used it as a mark for their arrows, the model of Francesco Sforza certainly did not survive. What, in that age, such work was capable of being — of what nobility, amid what racy truthfulness to fact — we may judge from the bronze statue of Bartolomeo Colleoni on horseback, modelled by Leonardo's master, Verrocchio (he died of grief, it was said, because, the mould accidentally failing, he was unable himself to complete it), still standing in the piazza of Saint John and Saint Paul at Venice. Some traces of the thing may remain in certain of Leonardo's drawings, and also, perhaps, by a singular circumstance, in a far-off town of France. For Ludovico became a prisoner, and ended his days at Loches in Touraine; — allowed at last, it is said, to breathe fresher air for awhile in one of the rooms of a high tower there, after many years of captivity in the dungeons below, where all seems sick with barbarous feudal memories, and where his prison is still shown, its walls covered with strange painted arabesques, ascribed by tradition to his hand, amused a little, in this way, through the tedious years: — vast helmets and faces and pieces of armour, among which, in great letters, the motto *Infelix Sum* is woven in and out, and in which, perhaps, it is not too fanciful to see the fruit of a wistful after-dreaming over all those experiments with Leonardo on the armed figure of the great duke, that had occupied the two so often during the days of his good fortune at Milan.

The remaining years of Leonardo's life are more or less years of wandering. From his brilliant life at court he had saved nothing, and he returned to Florence a poor man. Perhaps necessity kept his spirit excited: the next four years are one prolonged rapture or ecstasy of invention. He painted the pictures of the Louvre, his most authentic works, which came there straight from the cabinet of Francis the First, at Fontainebleau. One picture of his, the Saint Anne — not the Saint Anne of the Louvre, but a mere cartoon, now in London — revived for a moment a sort of appreciation more common in an earlier time, when good pictures had still seemed miraculous; and for two days a crowd of people of all qualities passed in naive excitement through the chamber where it hung, and gave Leonardo a taste of Cimabue's triumph. But his work was less with the saints than with the living women of Florence; for he lived still in the polished

society that he loved, and in the houses of Florence, left perhaps a little subject to light thoughts by the death of Savonarola — the latest gossip (1869) is of an undraped Monna Lisa, found in some out-of-the-way corner of the late Orleans collection — he saw Ginevra di Benci, and Lisa, the young third wife of Francesco del Giocondo. As we have seen him using incidents of sacred story, not for their own sake, or as mere subjects for pictorial realisation, but as a symbolical language for fancies all his own, so now he found a vent for his thoughts in taking one of these languid women, and raising her, as Leda or Pomona, Modesty or Vanity, to the seventh heaven of symbolical expression.

La Gioconda is, in the truest sense, Leonardo's masterpiece, the revealing instance of his mode of thought and work. In suggestiveness, only the Melancholia of Duerer is comparable to it; and no crude symbolism disturbs the effect of its subdued and graceful mystery. We all know the face and hands of the figure, set in its marble chair, in that cirque of fantastic rocks, as in some faint light under sea. Perhaps of all ancient pictures time has chilled it least.* As often happens with works in which invention seems to reach its limits, there is an element in it given to, not invented by, the master. In that inestimable folio of drawings, once in the possession of Vasari, were certain designs by Verrocchio, faces of such impressive beauty that Leonardo in his boyhood copied them many times. It is hard not to connect with these designs of the elder, by-past master, as with its germinal principle, the unfathomable smile, always with a touch of something sinister in it, which plays over all Leonardo's work. Besides, the picture is a portrait. From childhood we see this image defining itself on the fabric of his dreams; and but for express historical testimony, we might fancy that this was but his ideal lady, embodied and beheld at last. What was the relationship of a living Florentine to this creature of his thought? By means of what strange affinities had the person and the dream grown up thus apart, and yet so closely together? Present from the first incorporeally in Leonardo's thought, dimly traced in the designs of Verrocchio, she is found present at last in Il Giocondo's house. That there is much of mere portraiture in the picture is attested by the legend that by artificial means, the presence of mimes and flute-players, that subtle expression was protracted on the face. Again, was it in four years and by renewed labour never really completed, or in four months and as by stroke of magic, that the image was projected?

*Yet for Vasari there was some further magic of crimson in the lips and cheeks, lost for us.

The presence that thus rose so strangely beside the waters, is expressive of what in the ways of a thousand years men had come to desire. Hers is the head upon which all "the ends of the world are come," and the eyelids are a little

weary. It is a beauty wrought out from within upon the flesh, the deposit, little cell by cell, of strange thoughts and fantastic reveries and exquisite passions. Set it for a moment beside one of those white Greek goddesses or beautiful women of antiquity, and how would they be troubled by this beauty, into which the soul with all its maladies has passed! All the thoughts and experience of the world have etched and moulded there, in that which they have of power to refine and make expressive the outward form, the animalism of Greece, the lust of Rome, the reverie of the middle age with its spiritual ambition and imaginative loves, the return of the Pagan world, the sins of the Borgias. She is older than the rocks among which she sits; like the vampire, she has been dead many times, and learned the secrets of the grave; and has been a diver in deep seas, and keeps their fallen day about her; and trafficked for strange webs with Eastern merchants: and, as Leda, was the mother of Helen of Troy, and, as Saint Anne, the mother of Mary; and all this has been to her but as the sound of lyres and flutes, and lives only in the delicacy with which it has moulded the changing lineaments, and tinged the eyelids and the hands. The fancy of a perpetual life, sweeping together ten thousand experiences, is an old one; and modern thought has conceived the idea of humanity as wrought upon by, and summing up in itself, all modes of thought and life. Certainly Lady Lisa might stand as the embodiment of the old fancy, the symbol of the modern idea.

During these years at Florence Leonardo's history is the history of his art; he himself is lost in the bright cloud of it. The outward history begins again in 1502, with a wild journey through central Italy, which he makes as the chief engineer of Caesar Borgia. The biographer, putting together the stray jottings of his manuscripts, may follow him through every day of it, up the strange tower of Siena, which looks towards Rome, elastic like a bent bow, down to the seashore at Piombino, each place appearing as fitfully as in a fever dream.

One other great work was left for him to do, a work all trace of which soon vanished, The Battle of the Standard, in which he had Michelangelo for his rival. The citizens of Florence, desiring to decorate the walls of the great council-chamber, had offered the work for competition, and any subject might be chosen from the Florentine wars of the fifteenth century. Michelangelo chose for his cartoon an incident of the war with Pisa, in which the Florentine soldiers, bathing in the Arno, are surprised by the sound of trumpets, and run to arms. His design has reached us only in an old engraving, which perhaps helps us less than what we remember of the background of his Holy Family in the Uffizii to imagine in what superhuman form, such as might have beguiled the heart of an earlier world, those figures may have risen from the water. Leonardo chose an incident from the battle of Anghiari, in which two parties of soldiers fight for a

standard. Like Michelangelo's, his cartoon is lost, and has come to us only in sketches, and in a fragment of Rubens. Through the accounts given we may discern some lust of terrible things in it, so that even the horses tore each other with their teeth; and yet one fragment of it, in a drawing of his at Florence, is far different — a waving field of lovely armour, the chased edgings running like lines of sunlight from side to side. Michelangelo was twenty-seven years old; Leonardo more than fifty; and Raffaello, then nineteen years old, visiting Florence for the first time, came and watched them as they worked.

We catch a glimpse of him again, at Rome in 1514, surrounded by his mirrors and vials and furnaces, making strange toys that seemed alive of wax and quicksilver. The hesitation which had haunted him all through life, and made him like one under a spell, was upon him now with double force. No one had ever carried political indifferentism farther; it had always been his philosophy to "fly before the storm"; he is for the Sforzas, or against them, as the tide of their fortune turns. Yet now in the political society of Rome, he came to be suspected of concealed French sympathies. It paralysed him to find himself among enemies; and he turned wholly to France, which had long courted him.

France was about to become an Italy more Italian than Italy itself. Francis the First, like Lewis the Twelfth before him, was attracted by the finesse of Leonardo's work; La Gioconda was already in his cabinet, and he offered Leonardo the little Chateau de Clou, with its vineyards and meadows, in the pleasant valley of the Masse, just outside the walls of the town of Amboise, where, especially in the hunting season, the court then frequently resided. A Monsieur Lyonard, peinteur du Roy pour Amboyse — so the letter of Francis the First is headed. It opens a prospect, one of the most interesting in the history of art, where, under a strange mixture of lights, Italian art dies away as a French exotic.

Two questions remain, after much busy antiquarianism, concerning Leonardo's death — the question of the precise form of his religion, and the question whether Francis the First was present at the time. They are of about equally little importance in the estimate of Leonardo's genius. The directions in his will about the thirty masses and the great candles for the church of Saint Florentin are things of course, their real purpose being immediate and practical; and on no theory of religion could these hurried offices be of much consequence. We forget them in speculating how one who had been always so desirous of beauty, but desired it always in such definite and precise forms, as hands or flowers or hair, looked forward now into the vague land, and experienced the last curiosity.

1869.

Extract from 'ESSAYS ON ART' by A. Clutton-Brock



This essay on the art of Leonardo forms the second chapter in Clutton-Brock's 1919 critical book *Essays on Art*.

LEONARDO DA VINCI

Leonardo da Vinci is one of the most famous men in history — as a man more famous than Michelangelo or Shakespeare or Mozart — because posterity has elected him the member for the Renaissance. Most great artists live in what they did, and by that we know them; but what Leonardo did gets much of its life from what he was, or rather from what he is to us. Of all great men he is the most representative; we cannot think of him as a mere individual, eating and drinking, living and competing, on equal terms with other men. We see him magnified by his own legend from the first, with people standing aside to watch and whisper as he passed through the streets of Florence or Milan. “There he goes to paint the Last Supper,” they said to each other; and we think of it as already the most famous picture in the world before it was begun. Every one knew that he had the most famous picture in his brain, that he was born to paint it, to initiate the High Renaissance; from Giotto onwards all the painters had been preparing for that, Florence herself had been preparing for it. It makes no difference that for centuries it has been a shadow on the wall; it is still the most famous painting in the world because it is the masterpiece of Leonardo. There was a fate against the survival of his masterpieces, but he has survived them and they are remembered because of him. We accept him for himself, like the people of his own time, who, when he said he could perform impossibilities, believed him. To them he meant the new age which could do anything, and still to us he means the infinite capacities of man. He is the Adam awakened whom Michelangelo only painted; and, if he accomplished but little, we believe in him, as in mankind, for his promise. If he did not fulfil it, neither has mankind; but he believed that all things could be done and lived a great life in that faith.

Another Florentine almost equals him in renown. Men watched and whispered when Dante passed through the streets of Florence; but Dante lives in his achievement, Leonardo in himself. Dante means to us an individual soul quivering through a system, a creed, inherited from the past. Leonardo is a spirit unstraitened; not consenting to any past nor rebelling against it, but newborn with a newborn universe around it, seeing it without memories or superstitions, without inherited fears or pieties, yet without impiety or irreverence. He is not an iconoclast, since for him there are no images to be broken; whatever he sees is not an image but itself, to be accepted or rejected by himself; what he would do he does without the help or hindrance of tradition. In art and in science he means the same thing, not a rebirth of any past, as the word Renaissance seems to

imply, but freedom from all the past, life utterly in the present. He is concerned not with what has been thought, or said, or done, but with his own immediate relation to all things, with what he sees and feels and discovers. Authority is nothing to him, whether of Galen or of St. Thomas, of Greek or mediæval art. In science he looks at the fact, in art at the object; nor will he allow either to be hidden from him by the achievements of the dead. Giotto had struck the first blow for freedom when he allowed the theme to dictate the picture; Leonardo allowed the object to dictate the drawing. To him the fact itself is sacred, and man fulfils himself in his own immediate relation to fact.

All those who react and rebel against the Renaissance have an easy case against its great representative. What did he do in thought compared with St. Thomas, or in art compared with the builders of Chartres or Bourges? He filled notebooks with sketches and conjectures; he modelled a statue that was never cast; he painted a fresco on a wall, and with a medium so unsuited to fresco that it was a ruin in a few years. Even in his own day there was a doubt about him; it is expressed in the young Michelangelo's sudden taunt that he could not cast the statue he had modelled. Michelangelo was one of those who see in life always the great task to be performed and who judge a man by his performance; to him Leonardo was a dilettante, a talker; he made monuments, but Leonardo remains his own monument, a prophecy of what man shall be when he comes into his kingdom. With him, we must confess, it is more promise than performance; he could paint "The Last Supper" because it means the future; he could never, in good faith, have painted "The Last Judgment," for that means a judgment on the past, and to him the past is nothing; to him man, in the future, is the judge, master, enjoyer of his own fate. Compared with his, Michelangelo's mind was still mediæval, his reproach the reproach of one who cares for doing more than for being, and certainly Michelangelo did a thousand times more; but from his own day to ours the world has not judged Leonardo by his achievement. As Johnson had his Boswell so he has had his legend; he means to us not books or pictures, but himself. In his own day kings bid for him as if he were a work of art; and he died magnificently in France, making nothing but foretelling a race of men not yet fulfilled.

Before Francis Bacon, before Velasquez or Manet, he prophesied not merely the new artist or the new man of science, but the new man who is to free himself from his inheritance and to see, feel, think, and act in all things with the spontaneity of God. That is why he is a legendary hero to us, with a legend that is not in the past but in the future. For his prophecy is still far from fulfilment; and the very science that he initiated tells us how hard it is for man to free himself from his inheritance. It seems strange to us that Leonardo sang hymns to

causation as if to God. In its will was his peace and his freedom.

O marvellous necessity, thou with supreme reason constrainest all efforts to be the direct result of their causes, and by a supreme and irrevocable law every natural action obeys thee by the shortest possible process.

Who would believe that so small a space could contain the images of all the universe? O mighty process, what talent can avail to penetrate a nature such as thine? What tongue will it be that can unfold so great a wonder? Verily none. This it is that guides the human discourse to the considering of divine things.

The sayings of Leonardo quoted in this article are taken from *Leonardo da Vinci's Notebooks*, by E. M'Curdy. (Duckworth, 1906.)

To Leonardo causation meant the escape from caprice; it meant a secure relation between man and all things, in which man would gain power by knowledge, in which every increase of knowledge would reveal to him more and more of the supreme reason. There was no chain for him in cause and effect, no unthinking of the will of man. Rather by knowledge man would discover his own will and know that it was the universal will. So man must never be afraid of knowledge. "The eye is the window of the soul." Like Whitman he tells us always to look with the eye, and so to confound the wisdom of ages. There is in every man's vision the power of relating himself now and directly to reality by knowledge; and in knowing other things he knows himself. By knowledge man changes what seemed to be a compulsion into a harmony; he gives up his own caprice for the universal will.

That is the religion of Leonardo, in art as in science. For him the artist also must relate himself directly to the visible world, in which is the only inspiration; to accept any formula is to see with dead men's eyes. That has been said again and again by artists, but not with Leonardo's mystical and philosophical conviction. He knew that it is vain to study Nature unless she is to you a goddess or a god; you can learn nothing from reality unless you adore it, and in adoring it he found his freedom. How different is this doctrine from that with which, after centuries of scientific advance, we intimidate ourselves. We are threatened by a creed far more enslaving than that of the Middle Ages. If the Middle Ages turned to the past to learn what they were to think or to do, we turn to the past to learn what we are. They may have feared the new; but we say that there is no new, nothing but some combination or variation of the old. Causation is to us a chain that binds us to the past, but to Leonardo it was freedom; and so he prophesies a freedom that we may attain to not by denying facts or making myths, but by discovering what he hinted — that causation itself is not compulsion but will, and our will if, by knowledge, we make it ours.

No one before him had been so much in love with reality, whatever it may be. He was called a sceptic, but it was only that he preferred reality itself to any tales about it; and his religion, his worship, was the search for the very fact. This, because he was both artist and man of science, he carried further than anyone else, pursuing it with all his faculties. In his drawings there is the beauty not of his character, but of the character of what he draws; he does not make a design, but finds it. That beauty proves him a Florentine — Dürer himself falls short of it — but it is the beauty of the thing itself, discovered and insisted upon with the passion of a lover. He draws animals, trees, flowers, as Correggio draws Antiope or Io; and it is only in his drawings now that he speaks clearly to us. The “Mona Lisa” is well enough, but another hand might have executed the painting of it. It owes its popular fame to the smile about which it is so easy to write finely; but in the drawings we see the experiencing passion of Leonardo himself, we see him feeling, as in the notebooks we see him thinking. There is the eagerness of discovery at which so often he stopped short, turning away from a task to further discovery, living always in the moment, taking no thought either for the morrow or for yesterday, unable to attend to any business, even the business of the artist, seeing life not as a struggle or a duty, but as an adventure of all the senses and all the faculties. He is, even with his pencil, the greatest talker in the world, but without egotism, talking always of what he sees, satisfying himself not with the common appetites and passions of men, but with his one supreme passion for reality. If Michelangelo thought him a dilettante, there must have been in his taunt some envy of Leonardo’s freedom.

Yet once at least Leonardo did achieve, and something we should never have expected from his drawings. “The Last Supper” is but a shadow on the wall, yet still we can see its greatness, which is the greatness of pure design, of Giotto, Masaccio, Piero della Francesca. Goethe and others have found all kinds of psychological subtleties in it, meanings in every gesture; but what we see now is only space, grandeur, a supreme moment expressed in the relation of all the forms. The pure music of the painting remains when the drama is almost obliterated; and it proves that Leonardo, when he chose, could withdraw himself from the delight of hand-to-mouth experience into a vision of his own, that he had the reserve and the creative power of the earlier masters and of that austere, laborious youth who taunted him. If it were not for “The Last Supper” we might doubt whether he could go further in art than the vivid sketch of “The Magi”; but “The Last Supper” tells us how great his passion for reality must have been, since it could distract him from the making of such masterpieces.

That passion for reality itself made him cold to other passions. We know Michelangelo and Beethoven as men in some respects very like other men. They

were anxious, fretful, full of affections and grievances, and much concerned with their relations. Leonardo is like Melchizedek, not only by the accident of birth, for he was a natural son, but by choice. He never married, he never had a home; there is no evidence that he was ever tied to any man or woman by his affections; yet it would be stupid to call him cold, for his one grand passion absorbed him. Monks suspected him, but in his heart he was celibate like the great monkish saints, celibate not by vows but by preoccupation. It is clear that from youth to age life had no cumulative power over him; as we should say in our prosaic language, he never settled down, for he let things happen to him and valued the very happening. He was always like a strange, wonderful creature from another planet, taking notes with unstaled delight but never losing his heart to any particular. Sex itself seems hardly to exist for him, or at least for his mind. Often the people in his drawings are of no sex. Rembrandt draws every one, Leonardo no one, as if he were his own relation. Women and youths were as much a subject of his impassioned curiosity as flowers, and no more. He is always the spectator, but a spectator who can exercise every faculty of the human mind and every passion in contemplation; he is the nearest that any man has ever come to Aristotle's Supreme Being.

But we must not suppose that he went solemnly through life living up to his own story, that he was mysterious in manner or in any respect like a charlatan. Rather, he lived always in the moment and overcame mankind by his spontaneity. He had the charm of the real man of genius, not the reserve of the false one. The famous statement of what he could do, which he made to Ludovico Sforza, is not a mere boast but an expression of his eagerness to do it. These engines of war were splendid toys to him, and all his life he enjoyed making toys and seeing men wonder at them. His delight was to do things for the first time like a child, and then not to do them again. Again and again he cries out against authority and in favour of discovery. "Whoever in discussion adduces authority," he says, "uses not intellect but rather memory"; and, anticipating Milton, he observes that all our knowledge originates in opinions. Perhaps some one had rebuked him for having too many opinions. We can be sure that he chafed against dull, cautious, safe men who wished for results. He himself cared nothing for them; it was enough for him to know what might be done, without doing it. He was so sure of his insight that he did not care to put it to the test of action; that was for slower men, whether artists or men of science. His notebooks were enough for him.

In spite of the notebooks and the sketches, we know less about the man Leonardo than about the man Shakespeare. Here and there he makes a remark with some personal conviction or experience in it. "Intellectual passion," he

says, “drives out sensuality.” In him it had driven out or sublimated all the sensual part of character. We cannot touch or see or hear him in anything he says or draws. The passion is there, but it is too much concerned with universals to be of like nature with our own passions. He seems to be speaking to himself as if he had forgotten the whole audience of mankind, but in what he says he ignores the personal part of himself; he is most passionate when most impersonal. “To the ambitious, whom neither the boon of life nor the beauty of the world suffices to content, it comes as a penance that life with them is squandered and that they possess neither the benefits nor the beauty of the world.” That might be a platitude said by some one else; but we know that in it Leonardo expresses his faith. The boon of life, the beauty of the world, were enough for him without ambition, without even further affections. He left father and mother and wealth, and even achievement, to follow them; and he left all those not out of coldness, or fear, or idleness, but because his own passion drew him away. No cold man could have said, “Where there is most power of feeling, there of martyrs is the greatest martyr.” It is difficult for us northerners to understand the intellectual passion of the South, to see even that it is passion; most difficult of all for us to see that in men like Leonardo the passion for beauty itself is intellectual. We, with our romanticism, our sense of exile, can never find that identity which he found between beauty and reality. “This benign nature so provides that all over the world you find something to imitate.” To us imitation means prose, to him it meant poetry; science itself meant poetry, and illusion was the only ugliness. “Nature never breaks her own law.” It is we who try to find freedom in lawlessness, which is ignorance, ugliness, illusion. “Falsehood is so utterly vile that, though it should praise the great works of God, it offends against His divinity.” There is Leonardo’s religion; and if still it is too cold for us, it is because we have not his pure spiritual fire in ourselves.

The Biographies



Vinci, Leonardo's birthplace

LIFE OF LEONARDO DA VINCI by Giorgio Vasari



Translated by Gaston du C. de Vere

Giorgio Vasari (1511-1574) was an Italian painter, writer, historian and architect, who is famous today for his biographies of Italian artists, now considered to be the founding works of art historical writing. Vasari was befriended by Michelangelo, whose painting style influenced his own. In 1529, he visited Rome and studied the works of Raphael and other artists of the Roman High Renaissance. Vasari's own Mannerist paintings were more admired in his lifetime than afterwards.

Vasari coined the term "Renaissance", which he often uses in his *Le Vite de' più eccellenti pittori, scultori, ed architettori* (Lives of the Most Eminent Painters, Sculptors, and Architects), his great biographical work, which was first published in 1550. It included a valuable treatise on the technical methods employed in the arts. Partly rewritten and enlarged in 1568, the collection was illustrated with woodcut portraits of artists.

The work has a consistent, even notorious, bias in favour of Florentines and tends to attribute to them all the developments in Renaissance art — for example, the invention of engraving. Venetian art in particular (along with arts from other parts of Europe), is systematically ignored in the first edition. Nevertheless, the book has for centuries been the most important source of information on early Renaissance Italian painters and the attribution of their paintings. Leonardo's life begins the fourth part of the great biographical work.



Giorgio Vasari, Leonardo's first biographer

LIFE OF LEONARDO DA VINCI

PAINTER AND SCULPTOR OF FLORENCE

The greatest gifts are often seen, in the course of nature, rained by celestial influences on human creatures; and sometimes, in supernatural fashion, beauty, grace, and talent are united beyond measure in one single person, in a manner that to whatever such an one turns his attention, his every action is so divine, that, surpassing all other men, it makes itself clearly known as a thing bestowed by God (as it is), and not acquired by human art. This was seen by all mankind in Leonardo da Vinci, in whom, besides a beauty of body never sufficiently extolled, there was an infinite grace in all his actions; and so great was his genius, and such its growth, that to whatever difficulties he turned his mind, he solved them with ease. In him was great bodily strength, joined to dexterity, with a spirit and courage ever royal and magnanimous; and the fame of his name so increased, that not only in his lifetime was he held in esteem, but his reputation became even greater among posterity after his death.

Truly marvellous and celestial was Leonardo, the son of Ser Piero da Vinci; and in learning and in the rudiments of letters he would have made great proficiencie, if he had not been so variable and unstable, for he set himself to learn many things, and then, after having begun them, abandoned them. Thus, in arithmetic, during the few months that he studied it, he made so much progress, that, by continually suggesting doubts and difficulties to the master who was teaching him, he would very often bewilder him. He gave some little attention to music, and quickly resolved to learn to play the lyre, as one who had by nature a spirit most lofty and full of refinement: wherefore he sang divinely to that instrument, improvising upon it. Nevertheless, although he occupied himself with such a variety of things, he never ceased drawing and working in relief, pursuits which suited his fancy more than any other. Ser Piero, having observed this, and having considered the loftiness of his intellect, one day took some of his drawings and carried them to Andrea del Verrocchio, who was much his friend, and besought him straitly to tell him whether Leonardo, by devoting himself to drawing, would make any proficiencie. Andrea was astonished to see the extraordinary beginnings of Leonardo, and urged Ser Piero that he should make him study it; wherefore he arranged with Leonardo that he should enter the workshop of Andrea, which Leonardo did with the greatest willingness in the world. And he practised not one branch of art only, but all those in which drawing played a part; and having an intellect so divine and marvellous that he

was also an excellent geometrician, he not only worked in sculpture, making in his youth, in clay, some heads of women that are smiling, of which plaster casts are still taken, and likewise some heads of boys which appeared to have issued from the hand of a master; but in architecture, also, he made many drawings both of ground-plans and of other designs of buildings; and he was the first, although but a youth, who suggested the plan of reducing the river Arno to a navigable canal from Pisa to Florence. He made designs of flour-mills, fulling-mills, and engines, which might be driven by the force of water: and since he wished that his profession should be painting, he studied much in drawing after nature, and sometimes in making models of figures in clay, over which he would lay soft pieces of cloth dipped in clay, and then set himself patiently to draw them on a certain kind of very fine Rheims cloth, or prepared linen: and he executed them in black and white with the point of his brush, so that it was a marvel, as some of them by his hand, which I have in our book of drawings, still bear witness; besides which, he drew on paper with such diligence and so well, that there is no one who has ever equalled him in perfection of finish; and I have one, a head drawn with the style in chiaroscuro, which is divine.

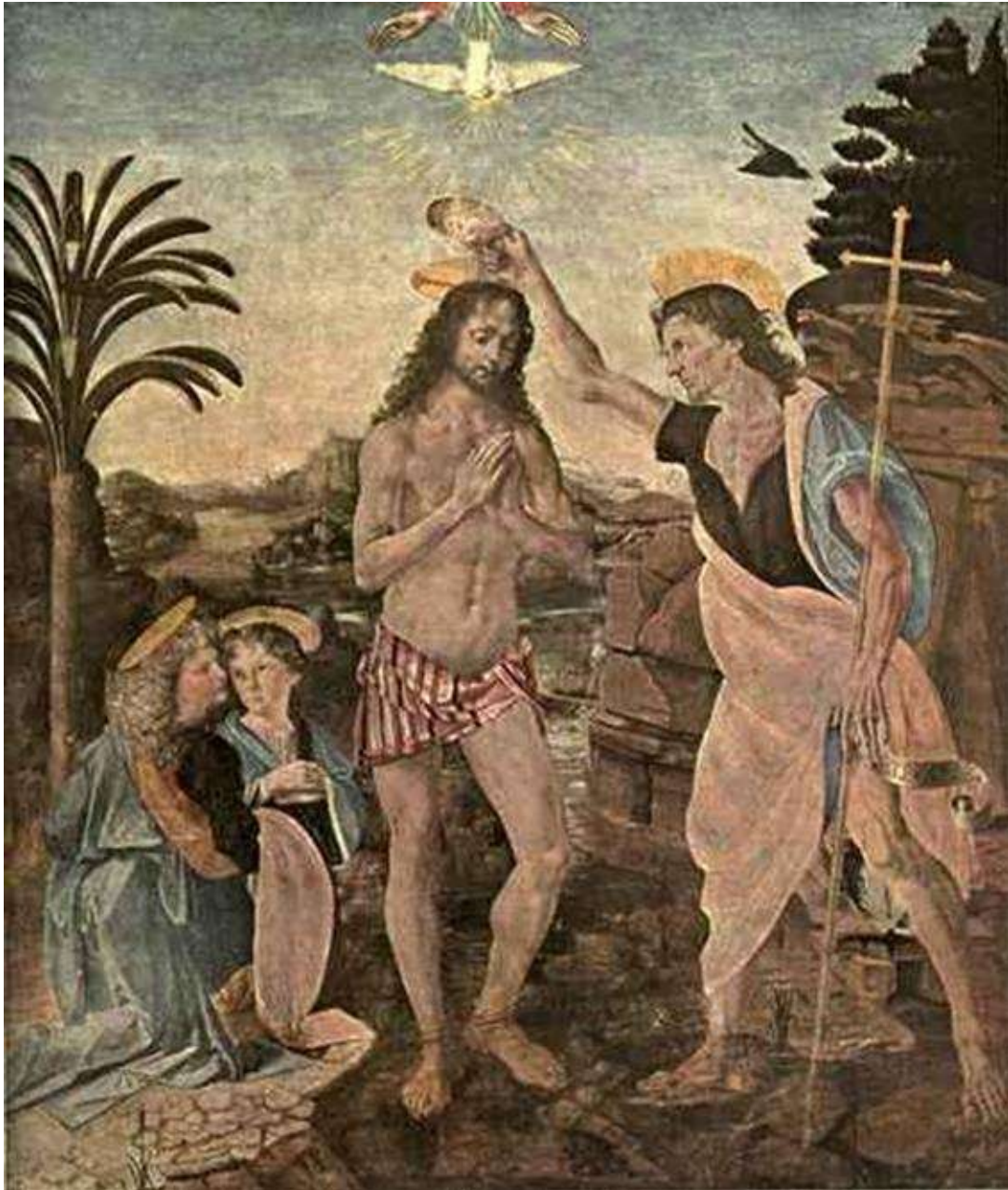
And there was infused in that brain such grace from God, and a power of expression in such sublime accord with the intellect and memory that served it, and he knew so well how to express his conceptions by draughtsmanship, that he vanquished with his discourse, and confuted with his reasoning, every valiant wit. And he was continually making models and designs to show men how to remove mountains with ease, and how to bore them in order to pass from one level to another; and by means of levers, windlasses, and screws, he showed the way to raise and draw great weights, together with methods for emptying harbours, and pumps for removing water from low places, things which his brain never ceased from devising; and of these ideas and labours many drawings may be seen, scattered abroad among our craftsmen; and I myself have seen not a few. He even went so far as to waste his time in drawing knots of cords, made according to an order, that from one end all the rest might follow till the other, so as to fill a round; and one of these is to be seen in stamp, most difficult and beautiful, and in the middle of it are these words, "Leonardus Vinci Accademia." And among these models and designs, there was one by which he often demonstrated to many ingenious citizens, who were then governing Florence, how he proposed to raise the Temple of S. Giovanni in Florence, and place steps under it, without damaging the building; and with such strong reasons did he urge this, that it appeared possible, although each man, after he had departed, would recognize for himself the impossibility of so vast an undertaking.

He was so pleasing in conversation, that he attracted to himself the hearts of

men. And although he possessed, one might say, nothing, and worked little, he always kept servants and horses, in which latter he took much delight, and particularly in all other animals, which he managed with the greatest love and patience; and this he showed when often passing by the places where birds were sold, for, taking them with his own hand out of their cages, and having paid to those who sold them the price that was asked, he let them fly away into the air, restoring to them their lost liberty. For which reason nature was pleased so to favour him, that, wherever he turned his thought, brain, and mind, he displayed such divine power in his works, that, in giving them their perfection, no one was ever his peer in readiness, vivacity, excellence, beauty, and grace.

It is clear that Leonardo, through his comprehension of art, began many things and never finished one of them, since it seemed to him that the hand was not able to attain to the perfection of art in carrying out the things which he imagined; for the reason that he conceived in idea difficulties so subtle and so marvellous, that they could never be expressed by the hands, be they ever so excellent. And so many were his caprices, that, philosophizing of natural things, he set himself to seek out the properties of herbs, going on even to observe the motions of the heavens, the path of the moon, and the courses of the sun.

He was placed, then, as has been said, in his boyhood, at the instance of Ser Piero, to learn art with Andrea del Verrocchio, who was making a panel-picture of S. John baptizing Christ, when Leonardo painted an angel who was holding some garments; and although he was but a lad, Leonardo executed it in such a manner that his angel was much better than the figures of Andrea; which was the reason that Andrea would never again touch colour, in disdain that a child should know more than he.



ANDREA VERROCCHIO: THE BAPTISM IN JORDAN
(*Florence: Accademia, 71. Panel*)

He was commissioned to make a cartoon for a door-hanging that was to be executed in Flanders, woven in gold and silk, to be sent to the King of Portugal, of Adam and Eve sinning in the Earthly Paradise; wherein Leonardo drew with the brush in chiaroscuro, with the lights in lead-white, a meadow of infinite kinds of herbage, with some animals, of which, in truth, it may be said that for diligence and truth to nature divine wit could not make it so perfect. In it is the fig-tree, together with the foreshortening of the leaves and the varying aspects of

the branches, wrought with such lovingness that the brain reels at the mere thought how a man could have such patience. There is also a palm-tree which has the radiating crown of the palm, executed with such great and marvellous art that nothing save the patience and intellect of Leonardo could avail to do it. This work was carried no farther; wherefore the cartoon is now at Florence, in the blessed house of the Magnificent Ottaviano de' Medici, presented to him not long ago by the uncle of Leonardo.

It is said that Ser Piero da Vinci, being at his villa, was besought as a favour, by a peasant of his, who had made a buckler with his own hands out of a fig-tree that he had cut down on the farm, to have it painted for him in Florence, which he did very willingly, since the countryman was very skilful at catching birds and fishing, and Ser Piero made much use of him in these pursuits. Thereupon, having had it taken to Florence, without saying a word to Leonardo as to whose it was, he asked him to paint something upon it. Leonardo, having one day taken this buckler in his hands, and seeing it twisted, badly made, and clumsy, straightened it by the fire, and, having given it to a turner, from the rude and clumsy thing that it was, caused it to be made smooth and even. And afterwards, having given it a coat of gesso, and having prepared it in his own way, he began to think what he could paint upon it, that might be able to terrify all who should come upon it, producing the same effect as once did the head of Medusa. For this purpose, then, Leonardo carried to a room of his own into which no one entered save himself alone, lizards great and small, crickets, serpents, butterflies, grasshoppers, bats, and other strange kinds of suchlike animals, out of the number of which, variously put together, he formed a great ugly creature, most horrible and terrifying, which emitted a poisonous breath and turned the air to flame; and he made it coming out of a dark and jagged rock, belching forth venom from its open throat, fire from its eyes, and smoke from its nostrils, in so strange a fashion that it appeared altogether a monstrous and horrible thing; and so long did he labour over making it, that the stench of the dead animals in that room was past bearing, but Leonardo did not notice it, so great was the love that he bore towards art. The work being finished, although it was no longer asked for either by the countryman or by his father, Leonardo told the latter that he might send for the buckler at his convenience, since, for his part, it was finished. Ser Piero having therefore gone one morning to the room for the buckler, and having knocked at the door, Leonardo opened to him, telling him to wait a little; and, having gone back into the room, he adjusted the buckler in a good light on the easel, and put to the window, in order to make a soft light, and then he bade him come in to see it. Ser Piero, at the first glance, taken by surprise, gave a sudden start, not thinking that that was the buckler, nor merely painted the form

that he saw upon it, and, falling back a step, Leonardo checked him, saying, "This work serves the end for which it was made; take it, then, and carry it away, since this is the effect that it was meant to produce." This thing appeared to Ser Piero nothing short of a miracle, and he praised very greatly the ingenious idea of Leonardo; and then, having privately bought from a pedlar another buckler, painted with a heart transfixed by an arrow, he presented it to the countryman, who remained obliged to him for it as long as he lived. Afterwards, Ser Piero sold the buckler of Leonardo secretly to some merchants in Florence, for a hundred ducats; and in a short time it came into the hands of the Duke of Milan, having been sold to him by the said merchants for three hundred ducats.

Leonardo then made a picture of Our Lady, a most excellent work, which was in the possession of Pope Clement VII; and, among other things painted therein, he counterfeited a glass vase full of water, containing some flowers, in which, besides its marvellous naturalness, he had imitated the dew-drops on the flowers, so that it seemed more real than the reality. For Antonio Segni, who was very much his friend, he made, on a sheet of paper, a Neptune executed with such careful draughtsmanship that it seemed absolutely alive. In it one saw the ocean troubled, and Neptune's car drawn by sea-horses, with fantastic creatures, marine monsters and winds, and some very beautiful heads of sea-gods. This drawing was presented by Fabio, the son of Antonio, to Messer Giovanni Gaddi, with this epigram:

Pinxit Virgilius Neptunum, pinxit Homerus, Dum maris undisoni per vada
flectit equos. Mente quidem vates illum conspexit uterque, Vincius ast oculis;
jureque vincit eos.



THE ADORATION OF THE MAGI (*After the panel by Leonardo da Vinci.*
Florence: Uffizi, 1252) Anderson

The fancy came to him to paint a picture in oils of the head of a Medusa, with the head attired with a coil of snakes, the most strange and extravagant invention that could ever be imagined; but since it was a work that took time, it remained unfinished, as happened with almost all his things. It is among the rare works of art in the Palace of Duke Cosimo, together with the head of an angel, who is raising one arm in the air, which, coming forward, is foreshortened from the shoulder to the elbow, and with the other he raises the hand to the breast.

It is an extraordinary thing how that genius, in his desire to give the highest relief to the works that he made, went so far with dark shadows, in order to find the darkest possible grounds, that he sought for blacks which might make deeper shadows and be darker than other blacks, that by their means he might make his lights the brighter; and in the end this method turned out so dark, that, no light remaining there, his pictures had rather the character of things made to represent an effect of night, than the clear quality of daylight; which all came from seeking to give greater relief, and to achieve the final perfection of art.

He was so delighted when he saw certain bizarre heads of men, with the beard or hair growing naturally, that he would follow one that pleased him a whole day, and so treasured him up in idea, that afterwards, on arriving home, he drew him as if he had had him in his presence. Of this sort there are many heads to be seen, both of women and of men, and I have several of them, drawn by his hand with the pen, in our book of drawings, which I have mentioned so many times; such was that of Amerigo Vespucci, which is a very beautiful head of an old man drawn with charcoal, and likewise that of Scaramuccia, Captain of the Gypsies, which afterwards came into the hands of M. Donato Valdambrini of Arezzo, Canon of S. Lorenzo, left to him by Giambullari.

He began a panel-picture of the Adoration of the Magi, containing many beautiful things, particularly the heads, which was in the house of Amerigo Benci, opposite the Loggia de' Peruzzi; and this, also, remained unfinished, like his other works.

It came to pass that Giovan Galeazzo, Duke of Milan, being dead, and Lodovico Sforza raised to the same rank, in the year 1494, Leonardo was summoned to Milan in great repute to the Duke, who took much delight in the sound of the lyre, to the end that he might play it: and Leonardo took with him that instrument which he had made with his own hands, in great part of silver, in the form of a horse's skull — a thing bizarre and new — in order that the harmony might be of greater volume and more sonorous in tone; with which he surpassed all the musicians who had come together there to play. Besides this, he was the best improviser in verse of his day. The Duke, hearing the marvellous discourse of Leonardo, became so enamoured of his genius, that it was something incredible: and he prevailed upon him by entreaties to paint an altar-panel containing a Nativity, which was sent by the Duke to the Emperor.

He also painted in Milan, for the Friars of S. Dominic, at S. Maria delle Grazie, a Last Supper, a most beautiful and marvellous thing; and to the heads of the Apostles he gave such majesty and beauty, that he left the head of Christ unfinished, not believing that he was able to give it that divine air which is essential to the image of Christ. This work, remaining thus all but finished, has

ever been held by the Milanese in the greatest veneration, and also by strangers as well; for Leonardo imagined and succeeded in expressing that anxiety which had seized the Apostles in wishing to know who should betray their Master. For which reason in all their faces are seen love, fear, and wrath, or rather, sorrow, at not being able to understand the meaning of Christ; which thing excites no less marvel than the sight, in contrast to it, of obstinacy, hatred, and treachery in Judas; not to mention that every least part of the work displays an incredible diligence, seeing that even in the tablecloth the texture of the stuff is counterfeited in such a manner that linen itself could not seem more real.



THE LAST SUPPER (*After the oil fresco by Leonardo da Vinci. Milan: S. Maria delle Grazie*) M.S.

It is said that the Prior of that place kept pressing Leonardo, in a most importunate manner, to finish the work; for it seemed strange to him to see Leonardo sometimes stand half a day at a time, lost in contemplation, and he would have liked him to go on like the labourers hoeing in his garden, without ever stopping his brush. And not content with this, he complained of it to the Duke, and that so warmly, that he was constrained to send for Leonardo and delicately urged him to work, contriving nevertheless to show him that he was doing all this because of the importunity of the Prior. Leonardo, knowing that the intellect of that Prince was acute and discerning, was pleased to discourse at large with the Duke on the subject, a thing which he had never done with the Prior: and he reasoned much with him about art, and made him understand that men of lofty genius sometimes accomplish the most when they work the least, seeking out inventions with the mind, and forming those perfect ideas which the hands afterwards express and reproduce from the images already conceived in the brain. And he added that two heads were still wanting for him to paint; that

of Christ, which he did not wish to seek on earth; and he could not think that it was possible to conceive in the imagination that beauty and heavenly grace which should be the mark of God incarnate. Next, there was wanting that of Judas, which was also troubling him, not thinking himself capable of imagining features that should represent the countenance of him who, after so many benefits received, had a mind so cruel as to resolve to betray his Lord, the Creator of the world. However, he would seek out a model for the latter; but if in the end he could not find a better, he should not want that of the importunate and tactless Prior. This thing moved the Duke wondrously to laughter, and he said that Leonardo had a thousand reasons on his side. And so the poor Prior, in confusion, confined himself to urging on the work in the garden, and left Leonardo in peace, who finished only the head of Judas, which seems the very embodiment of treachery and inhumanity; but that of Christ, as has been said, remained unfinished. The nobility of this picture, both because of its design, and from its having been wrought with an incomparable diligence, awoke a desire in the King of France to transport it into his kingdom; wherefore he tried by all possible means to discover whether there were architects who, with cross-stays of wood and iron, might have been able to make it so secure that it might be transported safely; without considering any expense that might have been involved thereby, so much did he desire it. But the fact of its being painted on the wall robbed his Majesty of his desire; and the picture remained with the Milanese. In the same refectory, while he was working at the Last Supper, on the end wall where is a Passion in the old manner, Leonardo portrayed the said Lodovico, with Massimiliano, his eldest son; and, on the other side, the Duchess Beatrice, with Francesco, their other son, both of whom afterwards became Dukes of Milan; and all are portrayed divinely well.

While he was engaged on this work, he proposed to the Duke to make a horse in bronze, of a marvellous greatness, in order to place upon it, as a memorial, the image of the Duke. And on so vast a scale did he begin it and continue it, that it could never be completed. And there are those who have been of the opinion (so various and so often malign out of envy are the judgments of men) that he began it with no intention of finishing it, because, being of so great a size, an incredible difficulty was encountered in seeking to cast it in one piece; and it might also be believed that, from the result, many may have formed such a judgment, since many of his works have remained unfinished. But, in truth, one can believe that his vast and most excellent mind was hampered through being too full of desire, and that his wish ever to seek out excellence upon excellence, and perfection upon perfection, was the reason of it. “*Tal che l’ opera fosse ritardata dal desio,*” as our Petrarca has said. And, indeed, those who saw the great model that

Leonardo made in clay vow that they have never seen a more beautiful thing, or a more superb; and it was preserved until the French came to Milan with King Louis of France, and broke it all to pieces. Lost, also, is a little model of it in wax, which was held to be perfect, together with a book on the anatomy of the horse made by him by way of study.



THE MADONNA AND CHILD WITH S. ANNE (*After the cartoon by Leonardo da Vinci. London: Burlington House*) Vasari Society

He then applied himself, but with greater care, to the anatomy of man, assisted

by and in turn assisting, in this research, Messer Marc' Antonio della Torre, an excellent philosopher, who was then lecturing at Pavia, and who wrote of this matter; and he was one of the first (as I have heard tell) that began to illustrate the problems of medicine with the doctrine of Galen, and to throw true light on anatomy, which up to that time had been wrapped in the thick and gross darkness of ignorance. And in this he found marvellous aid in the brain, work, and hand of Leonardo, who made a book drawn in red chalk, and annotated with the pen, of the bodies that he dissected with his own hand, and drew with the greatest diligence; wherein he showed all the frame of the bones; and then added to them, in order, all the nerves, and covered them with muscles; the first attached to the bone, the second that hold the body firm, and the third that move it; and beside them, part by part, he wrote in letters of an ill-shaped character, which he made with the left hand, backwards; and whoever is not practised in reading them cannot understand them, since they are not to be read save with a mirror. Of these papers on the anatomy of man, a great part is in the hands of Messer Francesco da Melzo, a gentleman of Milan, who in the time of Leonardo was a very beautiful boy, and much beloved by him, and now is a no less beautiful and gentle old man; and he holds them dear, and keeps such papers together as if they were relics, in company with the portrait of Leonardo of happy memory; and to all who read these writings, it seems impossible that that divine spirit should have discoursed so well of art, and of the muscles, nerves, and veins, and with such diligence of everything. So, also, there are in the hands of ———, a painter of Milan, certain writings of Leonardo, likewise in characters written with the left hand, backwards, which treat of painting, and of the methods of drawing and colouring. This man, not long ago, came to Florence to see me, wishing to print this work, and he took it to Rome, in order to put it into effect; but I do not know what may afterwards have become of it.

And to return to the works of Leonardo; there came to Milan, in his time, the King of France, wherefore Leonardo being asked to devise some bizarre thing, made a lion which walked several steps and then opened its breast, and showed it full of lilies.

In Milan he took for his assistant the Milanese Salai, who was most comely in grace and beauty, having fine locks, curling in ringlets, in which Leonardo greatly delighted; and he taught him many things of art; and certain works in Milan, which are said to be by Salai, were retouched by Leonardo.

He returned to Florence, where he found that the Servite Friars had entrusted to Filippino the painting of the panel for the high-altar of the Nunziata; whereupon Leonardo said that he would willingly have done such a work. Filippino, having heard this, like the amiable fellow that he was, retired from the

undertaking; and the friars, to the end that Leonardo might paint it, took him into their house, meeting the expenses both of himself and of all his household; and thus he kept them in expectation for a long time, but never began anything. In the end, he made a cartoon containing a Madonna and a S. Anne, with a Christ, which not only caused all the craftsmen to marvel, but, when it was finished, men and women, young and old, continued for two days to flock for a sight of it to the room where it was, as if to a solemn festival, in order to gaze at the marvels of Leonardo, which caused all those people to be amazed; for in the face of that Madonna was seen whatever of the simple and the beautiful can by simplicity and beauty confer grace on a picture of the Mother of Christ, since he wished to show that modesty and that humility which are looked for in an image of the Virgin, supremely content with gladness at seeing the beauty of her Son, whom she was holding with tenderness in her lap, while with most chastened gaze she was looking down at S. John, as a little boy, who was playing with a lamb; not without a smile from S. Anne, who, overflowing with joy, was beholding her earthly progeny become divine — ideas truly worthy of the brain and genius of Leonardo. This cartoon, as will be told below, afterwards went to France. He made a portrait of Ginevra d' Amerigo Benci, a very beautiful work; and abandoned the work for the friars, who restored it to Filippino; but he, also, failed to finish it, having been overtaken by death.

Leonardo undertook to execute, for Francesco del Giocondo, the portrait of Monna Lisa, his wife; and after toiling over it for four years, he left it unfinished; and the work is now in the collection of King Francis of France, at Fontainebleau. In this head, whoever wished to see how closely art could imitate nature, was able to comprehend it with ease; for in it were counterfeited all the minutenesses that with subtlety are able to be painted, seeing that the eyes had that lustre and watery sheen which are always seen in life, and around them were all those rosy and pearly tints, as well as the lashes, which cannot be represented without the greatest subtlety. The eyebrows, through his having shown the manner in which the hairs spring from the flesh, here more close and here more scanty, and curve according to the pores of the skin, could not be more natural. The nose, with its beautiful nostrils, rosy and tender, appeared to be alive. The mouth, with its opening, and with its ends united by the red of the lips to the flesh-tints of the face, seemed, in truth, to be not colours but flesh. In the pit of the throat, if one gazed upon it intently, could be seen the beating of the pulse. And, indeed, it may be said that it was painted in such a manner as to make every valiant craftsman, be he who he may, tremble and lose heart. He made use, also, of this device: Monna Lisa being very beautiful, he always employed, while he was painting her portrait, persons to play or sing, and jesters, who

might make her remain merry, in order to take away that melancholy which painters are often wont to give to the portraits that they paint. And in this work of Leonardo's there was a smile so pleasing, that it was a thing more divine than human to behold; and it was held to be something marvellous, since the reality was not more alive.

By reason, then, of the excellence of the works of this most divine craftsman, his fame had so increased that all persons who took delight in art — nay, the whole city of Florence — desired that he should leave them some memorial, and it was being proposed everywhere that he should be commissioned to execute some great and notable work, whereby the commonwealth might be honoured and adorned by the great genius, grace and judgment that were seen in the works of Leonardo. And it was decided between the Gonfalonier and the chief citizens, the Great Council Chamber having been newly built — the architecture of which had been contrived with the judgment and counsel of Giuliano da San Gallo, Simone Pollaiuolo, called Il Cronaca, Michelagnolo Buonarroti, and Baccio d' Agnolo, as will be related with more detail in the proper places — and having been finished in great haste, it was ordained by public decree that Leonardo should be given some beautiful work to paint; and so the said hall was allotted to him by Piero Soderini, then Gonfalonier of Justice. Whereupon Leonardo, determining to execute this work, began a cartoon in the Sala del Papa, an apartment in S. Maria Novella, representing the story of Niccolò Piccinino, Captain of Duke Filippo of Milan; wherein he designed a group of horsemen who were fighting for a standard, a work that was held to be very excellent and of great mastery, by reason of the marvellous ideas that he had in composing that battle; seeing that in it rage, fury, and revenge are perceived as much in the men as in the horses, among which two with the fore-legs interlocked are fighting no less fiercely with their teeth than those who are riding them do in fighting for that standard, which has been grasped by a soldier, who seeks by the strength of his shoulders, as he spurs his horse to flight, having turned his body backwards and seized the staff of the standard, to wrest it by force from the hands of four others, of whom two are defending it, each with one hand, and, raising their swords in the other, are trying to sever the staff; while an old soldier in a red cap, crying out, grips the staff with one hand, and, raising a scimitar with the other, furiously aims a blow in order to cut off both the hands of those who, gnashing their teeth in the struggle, are striving in attitudes of the utmost fierceness to defend their banner; besides which, on the ground, between the legs of the horses, there are two figures in foreshortening that are fighting together, and the one on the ground has over him a soldier who has raised his arm as high as possible, that thus with greater force he may plunge a dagger into his throat, in

order to end his life; while the other, struggling with his legs and arms, is doing what he can to escape death.

It is not possible to describe the invention that Leonardo showed in the garments of the soldiers, all varied by him in different ways, and likewise in the helmet-crests and other ornaments; not to mention the incredible mastery that he displayed in the forms and lineaments of the horses, which Leonardo, with their fiery spirit, muscles, and shapely beauty, drew better than any other master. It is said that, in order to draw that cartoon, he made a most ingenious stage, which was raised by contracting it and lowered by expanding. And conceiving the wish to colour on the wall in oils, he made a composition of so gross an admixture, to act as a binder on the wall, that, going on to paint in the said hall, it began to peel off in such a manner that in a short time he abandoned it, seeing it spoiling.



LEONARDO DA VINCI: MONNA LISA (*Formerly Paris: The Louvre, 1601. Canvas on Panel*)

Leonardo had very great spirit, and in his every action was most generous. It is said that, going to the bank for the allowance that he used to draw every month from Piero Soderini, the cashier wanted to give him certain paper-packets of pence; but he would not take them, saying in answer, "I am no penny-painter." Having been blamed for cheating Piero Soderini, there began to be murmurings against him; wherefore Leonardo so wrought upon his friends, that he got the money together and took it to Piero to repay him; but he would not

accept it.

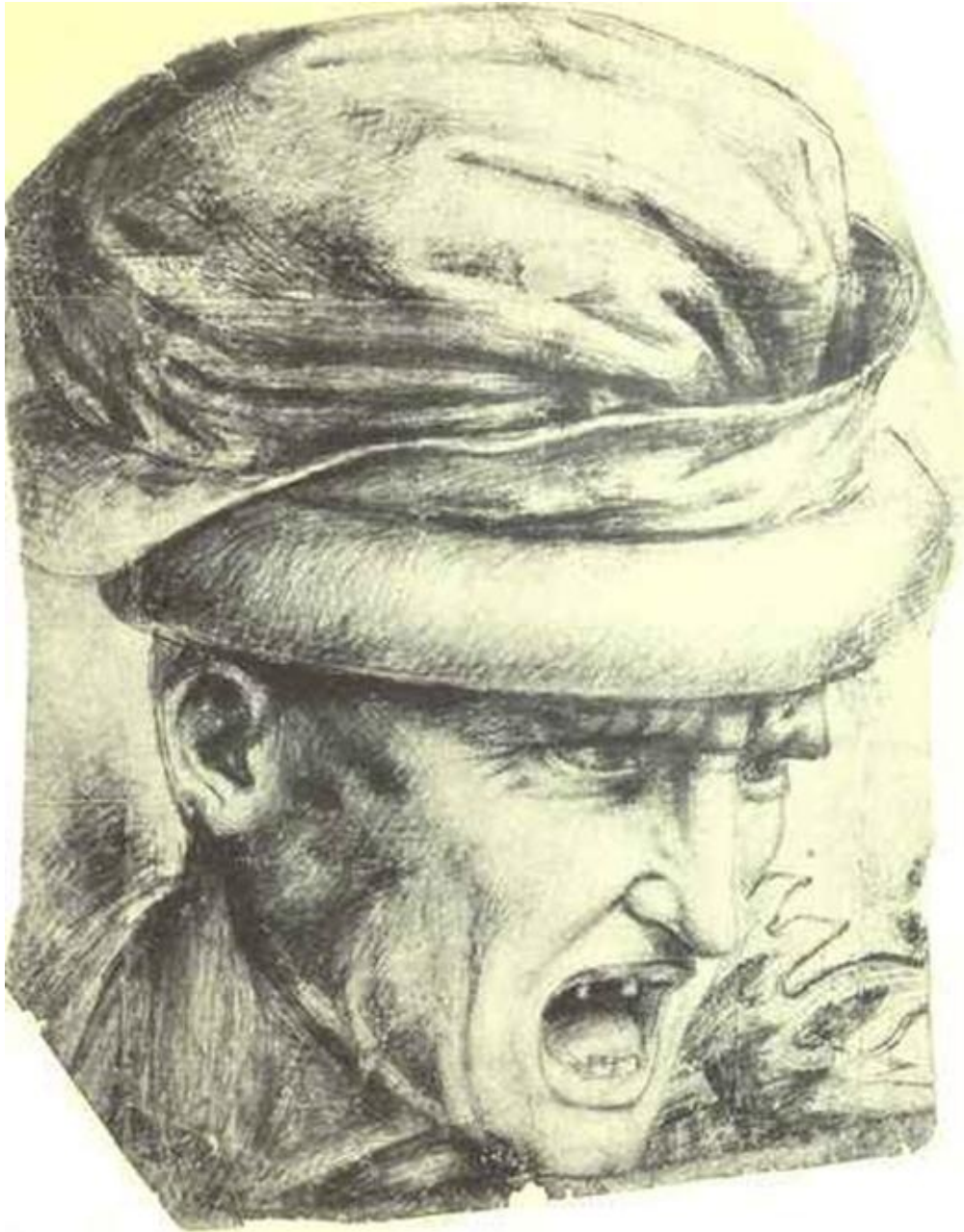
He went to Rome with Duke Giuliano de' Medici, at the election of Pope Leo, who spent much of his time on philosophical studies, and particularly on alchemy; where, forming a paste of a certain kind of wax, as he walked he shaped animals very thin and full of wind, and, by blowing into them, made them fly through the air, but when the wind ceased they fell to the ground. On the back of a most bizarre lizard, found by the vine-dresser of the Belvedere, he fixed, with a mixture of quicksilver, wings composed of scales stripped from other lizards, which, as it walked, quivered with the motion; and having given it eyes, horns, and beard, taming it, and keeping it in a box, he made all his friends, to whom he showed it, fly for fear. He used often to have the guts of a wether completely freed of their fat and cleaned, and thus made so fine that they could have been held in the palm of the hand; and having placed a pair of blacksmith's bellows in another room, he fixed to them one end of these, and, blowing into them, filled the room, which was very large, so that whoever was in it was obliged to retreat into a corner; showing how, transparent and full of wind, from taking up little space at the beginning they had come to occupy much, and likening them to virtue. He made an infinite number of such follies, and gave his attention to mirrors; and he tried the strangest methods in seeking out oils for painting, and varnish for preserving works when painted.

He made at this time, for Messer Baldassarre Turini da Pescia, who was Datary to Pope Leo, a little picture of the Madonna with the Child in her arms, with infinite diligence and art; but whether through the fault of whoever primed the panel with gesso, or because of his innumerable and capricious mixtures of grounds and colours, it is now much spoilt. And in another small picture he made a portrait of a little boy, which is beautiful and graceful to a marvel; and both of them are now at Pescia, in the hands of Messer Giuliano Turini. It is related that, a work having been allotted to him by the Pope, he straightway began to distil oils and herbs, in order to make the varnish; at which Pope Leo said: "Alas! this man will never do anything, for he begins by thinking of the end of the work, before the beginning."

There was very great disdain between Michelagnolo Buonarroti and him, on account of which Michelagnolo departed from Florence, with the excuse of Duke Giuliano, having been summoned by the Pope to the competition for the façade of S. Lorenzo. Leonardo, understanding this, departed and went into France, where the King, having had works by his hand, bore him great affection; and he desired that he should colour the cartoon of S. Anne, but Leonardo, according to his custom, put him off for a long time with words.

Finally, having grown old, he remained ill many months, and, feeling himself

near to death, asked to have himself diligently informed of the teaching of the Catholic faith, and of the good way and holy Christian religion; and then, with many moans, he confessed and was penitent; and although he could not raise himself well on his feet, supporting himself on the arms of his friends and servants, he was pleased to take devoutly the most holy Sacrament, out of his bed. The King, who was wont often and lovingly to visit him, then came into the room; wherefore he, out of reverence, having raised himself to sit upon the bed, giving him an account of his sickness and the circumstances of it, showed withal how much he had offended God and mankind in not having worked at his art as he should have done. Thereupon he was seized by a paroxysm, the messenger of death; for which reason the King having risen and having taken his head, in order to assist him and show him favour, to the end that he might alleviate his pain, his spirit, which was divine, knowing that it could not have any greater honour, expired in the arms of the King, in the seventy-fifth year of his age.



FRAGMENT FROM "THE BATTLE OF THE STANDARD" (*After the cartoon attributed to Leonardo da Vinci. Oxford: Ashmolean Museum*)

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The loss of Leonardo grieved beyond measure all those who had known him, since there was never any one who did so much honour to painting. With the splendour of his aspect, which was very beautiful, he made serene every broken spirit: and with his words he turned to yea, or nay, every obdurate intention. By his physical force he could restrain any outburst of rage: and with his right hand he twisted the iron ring of a door-bell, or a horse-shoe, as if it were lead. With

his liberality he would assemble together and support his every friend, poor or rich, if only he had intellect and worth. He adorned and honoured, in every action, no matter what mean and bare dwelling; wherefore, in truth, Florence received a very great gift in the birth of Leonardo, and an incalculable loss in his death. In the art of painting, he added to the manner of colouring in oils a certain obscurity, whereby the moderns have given great force and relief to their figures. And in statuary, he proved his worth in the three figures of bronze that are over the door of S. Giovanni, on the side towards the north, executed by Giovan Francesco Rustici, but contrived with the advice of Leonardo; which are the most beautiful pieces of casting, the best designed, and the most perfect that have as yet been seen in modern days. By Leonardo we have the anatomy of the horse, and that of man even more complete. And so, on account of all his qualities, so many and so divine, although he worked much more by words than by deeds, his name and fame can never be extinguished; wherefore it was thus said in his praise by Messer Giovan Battista Strozzi:

Vince costui pur solo Tutti altri; e vince Fidia e vince Apelle E tutto il lor vittorioso stuolo.



MAN AND WOMAN PRAYING (*After the panel by Giovan Antonio Boltraffio. Milan: Brera, 281) Anderson*

A disciple of Leonardo was Giovan Antonio Boltraffio of Milan, a person of great skill and understanding, who, in the year 1500, painted with much diligence, for the Church of the Misericordia, without Bologna, a panel in oils containing Our Lady with the Child in her arms, S. John the Baptist, S. Sebastian naked, and the patron who caused it to be executed, portrayed from the life, on his knees — a truly beautiful work, on which he wrote his name, calling himself a disciple of Leonardo. He has made other works, both at Milan and elsewhere;

but it must be enough here to have named this, which is the best. Another (of his disciples) was Marco Oggioni, who painted, in S. Maria della Pace, the Passing of Our Lady and the Marriage of Cana in Galilee.

***LEONARDO DA VINCI* by MAURICE W.
BROCKWELL**



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“Leonardo,” wrote an English critic as far back as 1721, “was a Man so happy in his genius, so consummate in his Profession, so accomplished in the Arts, so knowing in the Sciences, and withal, so much esteemed by the Age wherein he lived, his Works so highly applauded by the Ages which have succeeded, and his Name and Memory still preserved with so much Veneration by the present Age — that, if anything could equal the Merit of the Man, it must be the Success he met with. Moreover, ’tis not in Painting alone, but in Philosophy, too, that

Leonardo surpassed all his Brethren of the ‘Pencil.’”

This admirable summary of the great Florentine painter’s life’s work still holds good to-day.

HIS BIRTH

Leonardo Da Vinci, the many-sided genius of the Italian Renaissance, was born, as his name implies, at the little town of Vinci, which is about six miles from Empoli and twenty miles west of Florence. Vinci is still very inaccessible, and the only means of conveyance is the cart of a general carrier and postman, who sets out on his journey from Empoli at sunrise and sunset. Outside a house in the middle of the main street of Vinci to-day a modern and white-washed bust of the great artist is pointed to with much pride by the inhabitants. Leonardo's traditional birthplace on the outskirts of the town still exists, and serves now as the headquarters of a farmer and small wine exporter.

Leonardo di Ser Piero d'Antonio di Ser Piero di Ser Guido da Vinci — for that was his full legal name — was the natural and first-born son of Ser Piero, a country notary, who, like his father, grandfather, and great-grandfather, followed that honourable vocation with distinction and success, and who subsequently — when Leonardo was a youth — was appointed notary to the Signoria of Florence. Leonardo's mother was one Caterina, who afterwards married Accabriga di Piero del Vaccha of Vinci.



Plate II. — Annunciation In the Uffizi Gallery, Florence. No. 1288. 3 ft 3 ins. By 6 ft 11 ins. (0.99 x 2.18)] Although this panel is included in the Uffizi Catalogue as being by Leonardo, it is in all probability by his master, Verrocchio.]

The date of Leonardo's birth is not known with any certainty. His age is given

as five in a taxation return made in 1457 by his grandfather Antonio, in whose house he was educated; it is therefore concluded that he was born in 1452. Leonardo's father Ser Piero, who afterwards married four times, had eleven children by his third and fourth wives. Is it unreasonable to suggest that Leonardo may have had these numbers in mind in 1496-1498 when he was painting in his famous "Last Supper" the figures of eleven Apostles and one outcast?

However, Ser Piero seems to have legitimised his "love child" who very early showed promise of extraordinary talent and untiring energy.

HIS EARLY TRAINING

Practically nothing is known about Leonardo's boyhood, but Vasari informs us that Ser Piero, impressed with the remarkable character of his son's genius, took some of his drawings to Andrea del Verrocchio, an intimate friend, and begged him earnestly to express an opinion on them. Verrocchio was so astonished at the power they revealed that he advised Ser Piero to send Leonardo to study under him. Leonardo thus entered the studio of Andrea del Verrocchio about 1469-1470. In the workshop of that great Florentine sculptor, goldsmith, and artist he met other craftsmen, metal workers, and youthful painters, among whom was Botticelli, at that moment of his development a jovial *habitué* of the Poetical Supper Club, who had not yet given any premonitions of becoming the poet, mystic, and visionary of later times. There also Leonardo came into contact with that unoriginal painter Lorenzo di Credi, his junior by seven years. He also, no doubt, met Perugino, whom Michelangelo called "that blockhead in art." The genius and versatility of the Vincian painter was, however, in no way dulled by intercourse with lesser artists than himself; on the contrary he vied with each in turn, and readily outstripped his fellow pupils. In 1472, at the age of twenty, he was admitted into the Guild of Florentine Painters.

Unfortunately very few of Leonardo's paintings have come down to us. Indeed there do not exist a sufficient number of finished and absolutely authentic oil pictures from his own hand to afford illustrations for this short chronological sketch of his life's work. The few that do remain, however, are of so exquisite a quality — or were until they were "comforted" by the uninspired restorer — that we can unreservedly accept the enthusiastic records of tradition in respect of all his works. To rightly understand the essential characteristics of Leonardo's achievements it is necessary to regard him as a scientist quite as much as an artist, as a philosopher no less than a painter, and as a draughtsman rather than a colourist. There is hardly a branch of human learning to which he did not at one time or another give his eager attention, and he was engrossed in turn by the study of architecture — the foundation-stone of all true art — sculpture, mathematics, engineering and music. His versatility was unbounded, and we are apt to regret that this many-sided genius did not realise that it is by developing his power within certain limits that the great master is revealed. Leonardo may be described as the most Universal Genius of Christian times-perhaps of all time.



[PLATE III. THE VIRGIN OF THE ROCKS In the National Gallery. No. 1093. 6 ft. $\frac{1}{2}$ in. h. by 3 ft 9 $\frac{1}{2}$ in. w. (1.83 x 1.15)] This picture was painted in Milan about 1495 by Ambrogio da Predis under the supervision and guidance of Leonardo da Vinci, the essential features of the composition being borrowed from the earlier "Vierge aux Rochers," now in the Louvre.]

HIS EARLY WORKS



[Plate II. — *Annunciation* In the Uffizi Gallery, Florence. No. 1288. 3 ft 3 ins. By 6 ft 11 ins. (0.99 x 2.18)]

To about the year 1472 belongs the small picture of the “Annunciation,” now in the Louvre, which after being the subject of much contention among European critics has gradually won its way to general recognition as an early work by Leonardo himself. That it was painted in the studio of Verrocchio was always admitted, but it was long catalogued by the Louvre authorities under the name of Lorenzo di Credi. It is now, however, attributed to Leonardo (No. 1602 A). Such uncertainties as to attribution were common half a century ago when scientific art criticism was in its infancy.

Another painting of the “Annunciation,” which is now in the Uffizi Gallery (No. 1288) is still officially attributed to Leonardo. This small picture, which has been considerably repainted, and is perhaps by Andrea del Verrocchio, Leonardo’s master, is the subject of Plate II.

To January 1473 belongs Leonardo’s earliest dated work, a pen-and-ink drawing— “A Wide View over a Plain,” now in the Uffizi. The inscription together with the date in the top left-hand corner is reversed, and proves a remarkable characteristic of Leonardo’s handwriting — viz., that he wrote from right to left; indeed, it has been suggested that he did this in order to make it difficult for any one else to read the words, which were frequently committed to paper by the aid of peculiar abbreviations.

Leonardo continued to work in his master’s studio till about 1477. On January

1st of the following year, 1478, he was commissioned to paint an altar-piece for the Chapel of St. Bernardo in the Palazzo Vecchio, and he was paid twenty-five florins on account. He, however, never carried out the work, and after waiting five years the Signoria transferred the commission to Domenico Ghirlandajo, who also failed to accomplish the task, which was ultimately, some seven years later, completed by Filippino Lippi. This panel of the “Madonna Enthroned, St. Victor, St. John Baptist, St. Bernard, and St. Zenobius,” which is dated February 20, 1485, is now in the Uffizi.

That Leonardo was by this time a facile draughtsman is evidenced by his vigorous pen-and-ink sketch — now in a private collection in Paris — of Bernardo Bandini, who in the Pazzi Conspiracy of April 1478 stabbed Giuliano de’ Medici to death in the Cathedral at Florence during High Mass. The drawing is dated December 29, 1479, the date of Bandini’s public execution in Florence.

In that year also, no doubt, was painted the early and, as might be expected, unfinished “St. Jerome in the Desert,” now in the Vatican, the under-painting being in umber and *terraverte*. Its authenticity is vouched for not only by the internal evidence of the picture itself, but also by the similarity of treatment seen in a drawing in the Royal Library at Windsor. Cardinal Fesch, a princely collector in Rome in the early part of the nineteenth century, found part of the picture — the torso — being used as a box-cover in a shop in Rome. He long afterwards discovered in a shoemaker’s shop a panel of the head which belonged to the torso. The jointed panel was eventually purchased by Pope Pius IX., and added to the Vatican Collection.

In March 1480 Leonardo was commissioned to paint an altar-piece for the monks of St. Donato at Scopeto, for which payment in advance was made to him. That he intended to carry out this contract seems most probable. He, however, never completed the picture, although it gave rise to the supremely beautiful cartoon of the “Adoration of the Magi,” now in the Uffizi (No. 1252). As a matter of course it is unfinished, only the under-painting and the colouring of the figures in green on a brown ground having been executed. The rhythm of line, the variety of attitude, the profound feeling for landscape and an early application of chiaroscuro effect combine to render this one of his most characteristic productions.

Vasari tells us that while Verrocchio was painting the “Baptism of Christ” he allowed Leonardo to paint in one of the attendant angels holding some vestments. This the pupil did so admirably that his remarkable genius clearly revealed itself, the angel which Leonardo painted being much better than the portion executed by his master. This “Baptism of Christ,” which is now in the Accademia in Florence and is in a bad state of preservation, appears to have

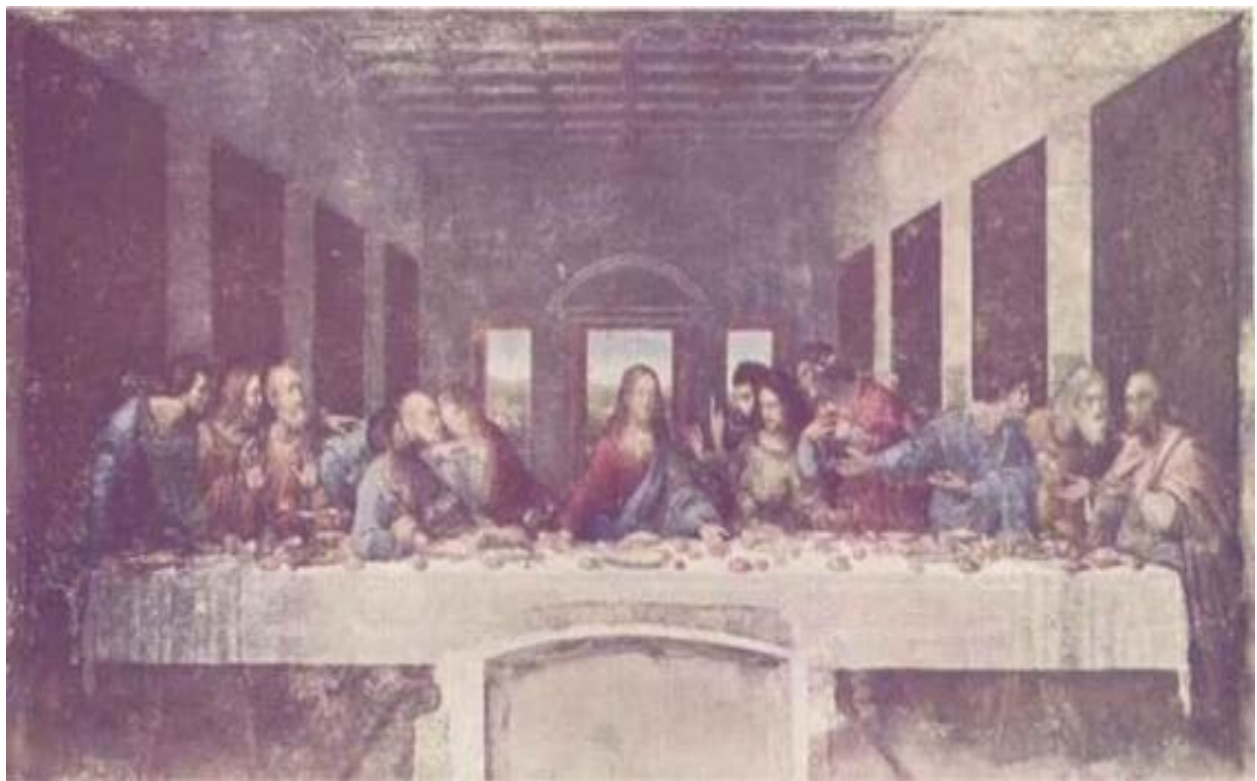
been a comparatively early work by Verrocchio, and to have been painted in 1480-1482, when Leonardo would be about thirty years of age.

To about this period belongs the superb drawing of the "Warrior," now in the Malcolm Collection in the British Museum. This drawing may have been made while Leonardo still frequented the studio of Andrea del Verrocchio, who in 1479 was commissioned to execute the equestrian statue of Bartolommeo Colleoni, which was completed twenty years later and still adorns the Campo di San Giovanni e Paolo in Venice.

FIRST VISIT TO MILAN

About 1482 Leonardo entered the service of Ludovico Sforza, having first written to his future patron a full statement of his various abilities in the following terms: —

“Having, most illustrious lord, seen and pondered over the experiments made by those who pass as masters in the art of inventing instruments of war, and having satisfied myself that they in no way differ from those in general use, I make so bold as to solicit, without prejudice to any one, an opportunity of informing your excellency of some of my own secrets.”



[PLATE IV.-THE LAST SUPPER Refectory of St. Maria delle Grazie, Milan. About 13 feet 8 ins. h. by 26 ft. 7 ins. w. (4.16 x 8.09)]

He goes on to say that he can construct light bridges which can be transported, that he can make pontoons and scaling ladders, that he can construct cannon and mortars unlike those commonly used, as well as catapults and other engines of

war; or if the fight should take place at sea that he can build engines which shall be suitable alike for defence as for attack, while in time of peace he can erect public and private buildings. Moreover, he urges that he can also execute sculpture in marble, bronze, or clay, and, with regard to painting, “can do as well as any one else, no matter who he may be.” In conclusion, he offers to execute the proposed bronze equestrian statue of Francesco Sforza “which shall bring glory and never-ending honour to that illustrious house.”

It was about 1482, the probable date of Leonardo’s migration from Florence to Milan, that he painted the “Vierge aux Rochers,” now in the Louvre (No. 1599). It is an essentially Florentine picture, and although it has no pedigree earlier than 1625, when it was in the Royal Collection at Fontainebleau, it is undoubtedly much earlier and considerably more authentic than the “Virgin of the Rocks,” now in the National Gallery (Plate III.).

He certainly set to work about this time on the projected statue of Francesco Sforza, but probably then made very little progress with it. He may also in that year or the next have painted the lost portrait of Cecilia Gallerani, one of the mistresses of Ludovico Sforza. It has, however, been surmised that that lady’s features are preserved to us in the “Lady with a Weasel,” by Leonardo’s pupil Boltraffio, which is now in the Czartoryski Collection at Cracow.

IN THE EAST

The absence of any record of Leonardo in Milan, or elsewhere in Italy, between 1483 and 1487 has led critics to the conclusion, based on documentary evidence of a somewhat complicated nature, that he spent those years in the service of the Sultan of Egypt, travelling in Armenia and the East as his engineer.

BACK IN MILAN

In 1487 he was again resident in Milan as general artificer — using that term in its widest sense — to Ludovico. Among his various activities at this period must be mentioned the designs he made for the cupola of the cathedral at Milan, and the scenery he constructed for “Il Paradiso,” which was written by Bernardo Bellincioni on the occasion of the marriage of Gian Galeazzo with Isabella of Aragon. About 1489-1490 he began his celebrated “Treatise on Painting” and recommenced work on the colossal equestrian statue of Francesco Sforza, which was doubtless the greatest of all his achievements as a sculptor. It was, however, never cast in bronze, and was ruthlessly destroyed by the French bowmen in April 1500, on their occupation of Milan after the defeat of Ludovico at the battle of Novara. This is all the more regrettable as no single authentic piece of sculpture has come down to us from Leonardo’s hand, and we can only judge of his power in this direction from his drawings, and the enthusiastic praise of his contemporaries.

This copy is usually ascribed to Marco d’Oggiono, but some critics claim that it is by Gianpetrino. It is the same size as the original.]

THE VIRGIN OF THE ROCKS

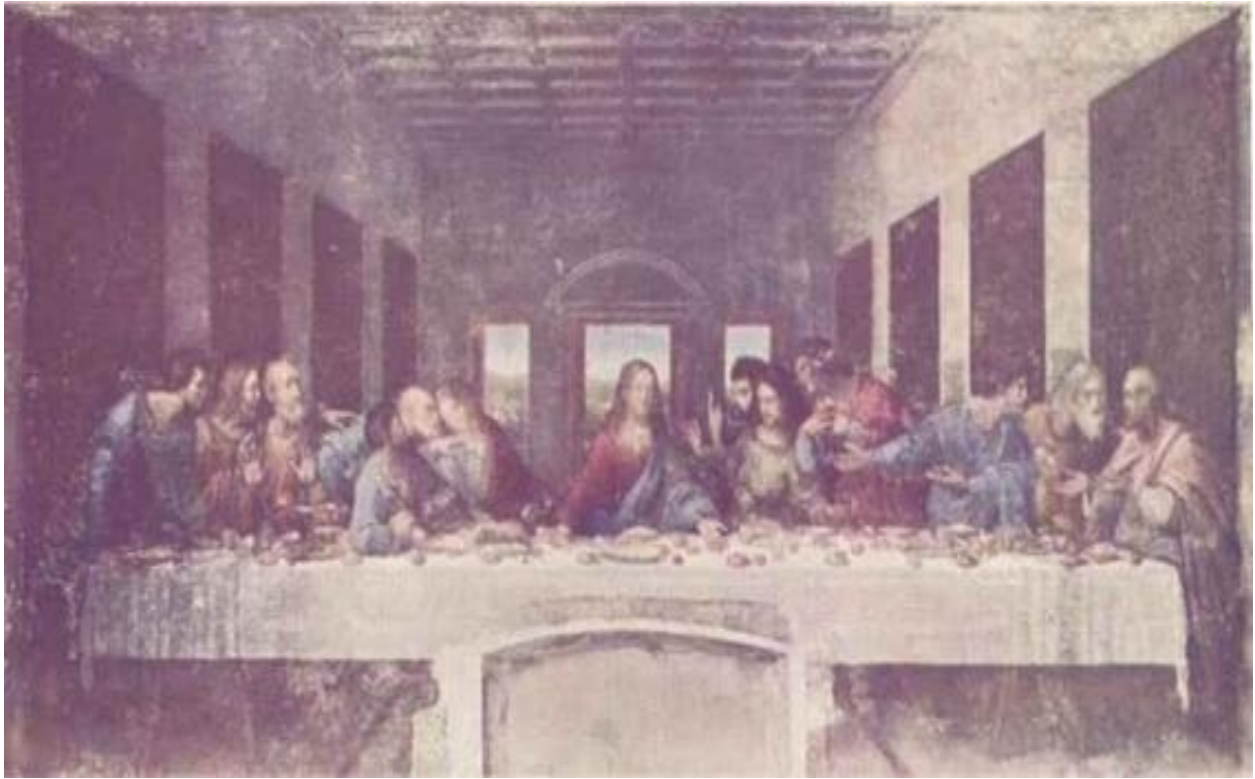


The “Virgin of the Rocks” (Plate III.), now in the National Gallery, corresponds exactly with a painting by Leonardo which was described by

Lomazzo about 1584 as being in the Chapel of the Conception in the Church of St. Francesco at Milan. This picture, the only *oeuvre* in this gallery with which Leonardo's name can be connected, was brought to England in 1777 by Gavin Hamilton, and sold by him to the Marquess of Lansdowne, who subsequently exchanged it for another picture in the Collection of the Earl of Suffolk at Charlton Park, Wiltshire, from whom it was eventually purchased by the National Gallery for £9000. Signor Emilio Motta, some fifteen years ago, unearthed in the State Archives of Milan a letter or memorial from Giovanni Ambrogio da Predis and Leonardo da Vinci to the Duke of Milan, praying him to intervene in a dispute, which had arisen between the petitioners and the Brotherhood of the Conception, with regard to the valuation of certain works of art furnished for the chapel of the Brotherhood in the church of St. Francesco. The only logical deduction which can be drawn from documentary evidence is that the "Vierge aux Rochers" in the Louvre is the picture, painted about 1482, which between 1491 and 1494 gave rise to the dispute, and that, when it was ultimately sold by the artists for the full price asked to some unknown buyer, the National Gallery version was executed for a smaller price mainly by Ambrogio da Predis under the supervision, and with the help, of Leonardo to be placed in the Chapel of the Conception.

The differences between the earlier, the more authentic, and the more characteristically Florentine "Vierge aux Rochers," in the Louvre, and the "Virgin of the Rocks," in the National Gallery, are that in the latter picture the hand of the angel, seated by the side of the Infant Christ, is raised and pointed in the direction of the little St. John the Baptist; that the St John has a reed cross and the three principal figures have gilt nimbi, which were, however, evidently added much later. In the National Gallery version the left hand of the Madonna, the Christ's right hand and arm, and the forehead of St. John the Baptist are freely restored, while a strip of the foreground right across the whole picture is ill painted and lacks accent. The head of the angel is, however, magnificently painted, and by Leonardo; the panel, taken as a whole, is exceedingly beautiful and full of charm and tenderness.

THE LAST SUPPER



Between 1496 and 1498 Leonardo painted his chef d'oeuvre, the "Last Supper," (Plate IV.) for the end wall of the Refectory of the Dominican Convent of S. Maria delle Grazie at Milan. It was originally executed in tempera on a badly prepared stucco ground and began to deteriorate a very few years after its completion. As early as 1556 it was half ruined. In 1652 the monks cut away a part of the fresco including the feet of the Christ to make a doorway. In 1726 one Michelangelo Belotti, an obscure Milanese painter, received £300 for the worthless labour he bestowed on restoring it. He seems to have employed some astringent restorative which revived the colours temporarily, and then left them in deeper eclipse than before. In 1770 the fresco was again restored by Mazza. In 1796 Napoleon's cavalry, contrary to his express orders, turned the refectory into a stable, and pelted the heads of the figures with dirt. Subsequently the refectory was used to store hay, and at one time or another it has been flooded. In 1820 the fresco was again restored, and in 1854 this restoration was effaced.

In October 1908 Professor Cavenaghi completed the delicate task of again restoring it, and has, in the opinion of experts, now preserved it from further injury. In addition, the devices of Ludovico and his Duchess and a considerable amount of floral decoration by Leonardo himself have been brought to light.

Leonardo has succeeded in producing the effect of the *coup de théâtre* at the moment when Jesus said "One of you shall betray me." Instantly the various apostles realise that there is a traitor among their number, and show by their different gestures their different passions, and reveal their different temperaments. On the left of Christ is St. John who is overcome with grief and is interrogated by the impetuous Peter, near whom is seated Judas Iscariot who, while affecting the calm of innocence, is quite unable to conceal his inner feelings; he instinctively clasps the money-bag and in so doing upsets the salt-cellar.

It will be remembered that the Prior of the Convent complained to Ludovico Sforza, Duke of Milan, that Leonardo was taking too long to paint the fresco and was causing the Convent considerable inconvenience. Leonardo had his revenge by threatening to paint the features of the impatient Prior into the face of Judas Iscariot. The incident has been quaintly told in the following lines: —

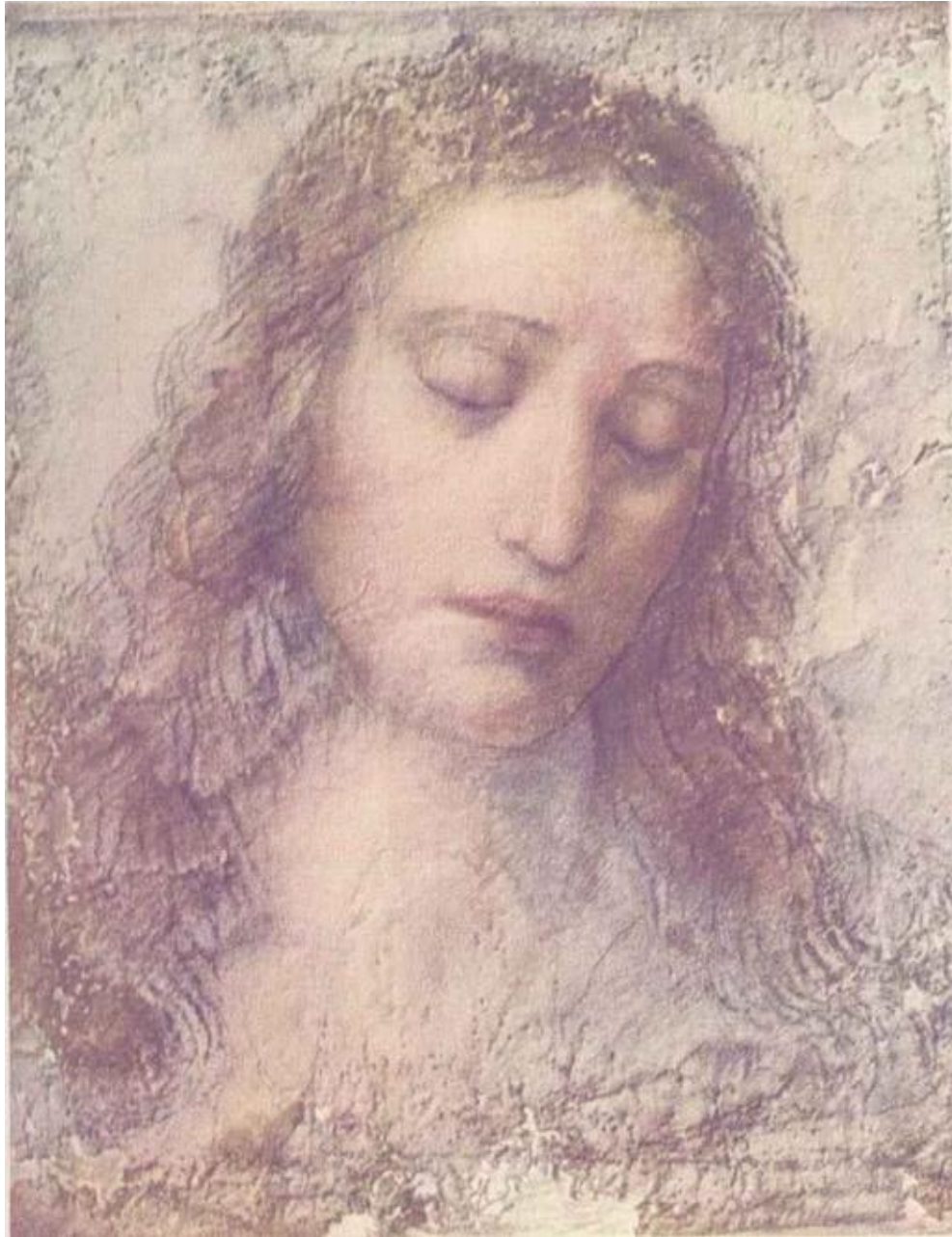
"Padre Bandelli, then, complains of me Because, forsooth, I have not drawn a line Upon the Saviour's head; perhaps, then, he Could without trouble paint that head divine. But think, oh Signor Duca, what should be The pure perfection of Our Saviour's face — What sorrowing majesty, what noble grace, At that dread moment when He brake the bread, And those submissive words of pathos said:

"'By one among you I shall be betrayed,' — And say if 'tis an easy task to find Even among the best that walk this Earth, The fitting type of that divinest worth, That has its image solely in the mind. Vainly my pencil struggles to express The sorrowing grandeur of such holiness. In patient thought, in ever-seeking prayer, I strive to shape that glorious face within, But the soul's mirror, dulled and dimmed by sin, Reflects not yet the perfect image there.

Can the hand do before the soul has wrought; Is not our art the servant of our thought?

"And Judas too, the basest face I see, Will not contain his utter infamy; Among the dregs and offal of mankind Vainly I seek an utter wretch to find. He who for thirty silver coins could sell His Lord, must be the Devil's miracle. Padre Bandelli thinks it easy is To find the type of him who with a kiss Betrayed his Lord. Well, what I can I'll do; And if it please his reverence and you, For Judas' face I'm willing to paint his."

”... I dare not paint Till all is ordered and matured within, Hand-work and head-work have an earthly taint, But when the soul commands I shall begin; On themes like these I should not dare to dwell With our good Prior — they to him would be Mere nonsense; he must touch and taste and see, And facts, he says, are never mystical.”



[PLATE VI. — THE HEAD OF CHRIST In the Brera Gallery, Milan. No. 280. 1 ft. 0-1/2 ins. by 1 ft. 4 ins. (0.32 x 0.40)]



The copy of the “Last Supper” (Plate V.) by Marco d’Oggiono, now in the Diploma Gallery at Burlington House, was made shortly after the original painting was completed. It gives but a faint echo of that sublime work “in which the ideal and the real were blended in perfect unity.” This copy was long in the possession of the Carthusians in their Convent at Pavia, and, on the suppression of that Order and the sale of their effects in 1793, passed into the possession of a grocer at Milan. It was subsequently purchased for £600 by the Royal Academy on the advice of Sir Thomas Lawrence, who left no stone unturned to acquire also the original studies for the heads of the Apostles. Some of these in red and black chalk are now preserved in the Royal Library at Windsor, where there are in all 145 drawings by Leonardo.

Several other old copies of the fresco exist, notably the one in the Louvre. Francis I. wished to remove the whole wall of the Refectory to Paris, but he was persuaded that that would be impossible; the Constable de Montmorency then had a copy made for the Chapel of the Château d’Ecouen, whence it ultimately passed to the Louvre.

The singularly beautiful “Head of Christ” (Plate VI.), now in the Brera Gallery at Milan, is the original study for the head of the principal figure in the fresco painting of the “Last Supper.” In spite of decay and restoration it expresses “the most elevated seriousness together with Divine Gentleness, pain on account of the faithlessness of His disciples, a full presentiment of His own death, and resignation to the will of His Father.”

THE COURT OF MILAN

Ludovico, to whom Leonardo was now court-painter, had married Beatrice d'Este, in 1491, when she was only fifteen years of age. The young Duchess, who at one time owned as many as eighty-four splendid gowns, refused to wear a certain dress of woven gold, which her husband had given her, if Cecilia Gallerani, the Sappho of her day, continued to wear a very similar one, which presumably had been given to her by Ludovico. Having discarded Cecilia, who, as her tastes did not lie in the direction of the Convent, was married in 1491 to Count Ludovico Bergamini, the Duke in 1496 became enamoured of Lucrezia Crivelli, a lady-in-waiting to the Duchess Beatrice.

Leonardo, as court painter, perhaps painted a portrait, now lost, of Lucrezia, whose features are more likely to be preserved to us in the portrait by Ambrogio da Predis, now in the Collection of the Earl of Roden, than in the quite unauthenticated portrait (Plate VII.), now in the Louvre (No. 1600).

On January 2, 1497, Beatrice spent three hours in prayer in the church of St. Maria delle Grazie, and the same night gave birth to a stillborn child. In a few hours she passed away, and from that moment Ludovico was a changed man. He went daily to see her tomb, and was quite overcome with grief.

In April 1498, Isabella d'Este, Beatrice's elder, more beautiful, and more graceful sister, "at the sound of whose name all the muses rise and do reverence" wrote to Cecilia Gallerani, or Bergamini, asking her to lend her the portrait which Leonardo had painted of her some fifteen years earlier, as she wished to compare it with a picture by Giovanni Bellini. Cecilia graciously lent the picture — now presumably lost — adding her regret that it no longer resembled her.

LEONARDO LEAVES MILAN

Among the last of Leonardo da Vinci's works in Milan towards the end of 1499 was, probably, the superb cartoon of "The Virgin and Child with St. Anne and St. John," now at Burlington House. Though little known to the general public, this large drawing on *carton*, or stiff paper, is one of the greatest of London's treasures, as it reveals the sweeping line of Leonardo's powerful draughtsmanship. It was in the Pompeo Leoni, Arconati, Casnedi, and Udney Collections before passing to the Royal Academy.

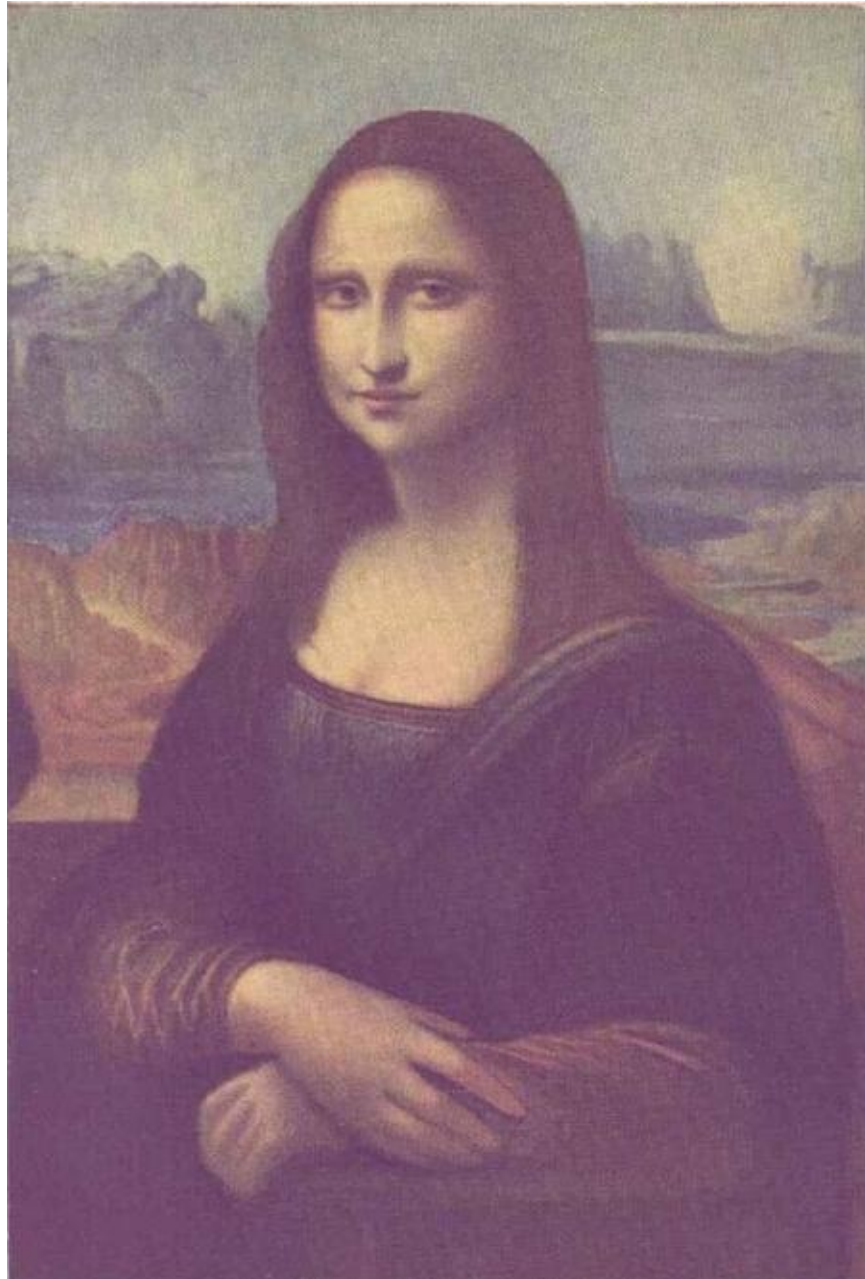
In 1499 the stormy times in Milan foreboded the end of Ludovico's reign. In April of that year we read of his giving a vineyard to Leonardo; in September Ludovico had to leave Milan for the Tyrol to raise an army, and on the 14th of the same month the city was sold by Bernardino di Corte to the French, who occupied it from 1500 to 1512. Ludovico may well have had in mind the figure of the traitor in the "Last Supper" when he declared that "Since the days of Judas Iscariot there has never been so black a traitor as Bernardino di Corte." On October 6th Louis XII. entered the city. Before the end of the year Leonardo, realising the necessity for his speedy departure, sent six hundred gold florins by letter of exchange to Florence to be placed to his credit with the hospital of S. Maria Nuova.

In the following year, Ludovico having been defeated at Novara, Leonardo was a homeless wanderer. He left Milan for Mantua, where he drew a portrait in chalk of Isabella d'Este, which is now in the Louvre. Leonardo eventually arrived in Florence about Easter 1500. After apparently working there in 1501 on a second Cartoon, similar in most respects to the one he had executed in Milan two years earlier, he travelled in Umbria, visiting Orvieto, Pesaro, Rimini, and other towns, acting as engineer and architect to Cesare Borgia, for whom he planned a navigable canal between Cesena and Porto Cese-natico.



[PLATE VII.-PORTRAIT (PRESUMED) OF LUCREZIA CRIVELLI In the Louvre. No. 1600 . 2 ft by 1 ft 5 ins. (0.62 x 0.44) This picture, although officially attributed to Leonardo, is probably not by him, and almost certainly does not represent Lucrezia Crivelli. It was once known as a "Portrait of a Lady" and is still occasionally miscalled "La Belle Féronnière."]

MONA LISA



Early in 1503 he was back again in Florence, and set to work in earnest on the “Portrait of Mona Lisa” (Plate I.), now in the Louvre (No. 1601). Lisa di Anton

Maria di Noldo Gherardini was the daughter of Antonio Gherardini. In 1495 she married Francesco di Bartolommeo de Zenobi del Giocondo. It is from the surname of her husband that she derives the name of “La Joconde,” by which her portrait is officially known in the Louvre. Vasari is probably inaccurate in saying that Leonardo “loitered over it for four years, and finally left it unfinished.” He may have begun it in the spring of 1501 and, probably owing to having taken service under Cesare Borgia in the following year, put it on one side, ultimately completing it after working on the “Battle of Anghiari” in 1504. Vasari’s eulogy of this portrait may with advantage be quoted: “Whoever shall desire to see how far art can imitate nature may do so to perfection in this head, wherein every peculiarity that could be depicted by the utmost subtlety of the pencil has been faithfully reproduced. The eyes have the lustrous brightness and moisture which is seen in life, and around them are those pale, red, and slightly livid circles, also proper to nature. The nose, with its beautiful and delicately roseate nostrils, might be easily believed to be alive; the mouth, admirable in its outline, has the lips uniting the rose-tints of their colour with those of the face, in the utmost perfection, and the carnation of the cheek does not appear to be painted, but truly flesh and blood. He who looks earnestly at the pit of the throat cannot but believe that he sees the beating of the pulses. Mona Lisa was exceedingly beautiful, and while Leonardo was painting her portrait, he took the precaution of keeping some one constantly near her to sing or play on instruments, or to jest and otherwise amuse her.”

Leonardo painted this picture in the full maturity of his talent, and, although it is now little more than a monochrome owing to the free and merciless restoration to which it has been at times subjected, it must have created a wonderful impression on those who saw it in the early years of the sixteenth century. It is difficult for the unpractised eye to-day to form any idea of its original beauty. Leonardo has here painted this worldly-minded woman — her portrait is much more famous than she herself ever was — with a marvellous charm and suavity, a finesse of expression never reached before and hardly ever equalled since. Contrast the head of the Christ at Milan, Leonardo’s conception of divinity expressed in perfect humanity, with the subtle and sphinx-like smile of this languorous creature.

The landscape background, against which Mona Lisa is posed, recalls the severe, rather than exuberant, landscape and the dim vistas of mountain ranges seen in the neighbourhood of his own birthplace. The portrait was bought during the reign of Francis I. for a sum which is to-day equal to about £1800. Leonardo, by the way, does not seem to have been really affected by any individual affection for any woman, and, like Michelangelo and Raphael, never married.

In January 4, 1504, Leonardo was one of the members of the Committee of Artists summoned to advise the Signoria as to the most suitable site for the erection of Michelangelo's statue of "David," which had recently been completed.

BATTLE OF ANGHIARI

In the following May he was commissioned by the Signoria to decorate one of the walls of the Council Hall of the Palazzo Vecchio. The subject he selected was the “Battle of Anghiari.” Although he completed the cartoon, the only part of the composition which he eventually executed in colour was an incident in the foreground which dealt with the “Battle of the Standard.” One of the many supposed copies of a study of this mural painting now hangs on the south-east staircase in the Victoria and Albert Museum. It depicts the Florentines under Cardinal Ludovico Mezzarota Scarampo fighting against the Milanese under Niccolò Piccinino, the General of Filippo Maria Visconti, on June 29, 1440.

AGAIN IN MILAN

Leonardo was back in Milan in May 1506 in the service of the French King, for whom he executed, apparently with the help of assistants, “the Madonna, the Infant Christ, and Saint Anne” (Plate VIII.). The composition of this oil-painting seems to have been built up on the second cartoon, which he had made some eight years earlier, and which was apparently taken to France in 1516 and ultimately lost.

IN ROME

From 1513-1515 he was in Rome, where Giovanni de' Medici had been elected Pope under the title of Leo X. He did not, however, work for the Pope, although he resided in the Vatican, his time being occupied in studying acoustics, anatomy, optics, geology, minerals, engineering, and geometry!

IN FRANCE

At last in 1516, three years before his death, Leonardo left his native land for France, where he received from Francis I. a princely income. His powers, however, had already begun to fail, and he produced very little in the country of his adoption. It is, nevertheless, only in the Louvre that his achievements as a painter can to-day be adequately studied.



[PLATE VIII.-MADONNA, INFANT CHRIST, AND ST. ANNE In the Louvre. No. 1508. 5 ft. 7 in. h. by 4 ft. 3 in. w. (1.70 x 1.29) Painted between 1509 and 1516 with the help of assistants.]

On October 10, 1516, when he was resident at the Manor House of Cloux near Amboise in Touraine with Francesco Melzi, his friend and assistant, he showed three of his pictures to the Cardinal of Aragon, but his right hand was now paralysed, and he could “no longer colour with that sweetness with which he was wont, although still able to make drawings and to teach others.”

It was no doubt in these closing years of his life that he drew the “Portrait of Himself” in red chalk, now at Turin, which is probably the only authentic portrait of him in existence.

HIS DEATH

On April 23, 1519 — Easter Eve — exactly forty-five years before the birth of Shakespeare, Leonardo da Vinci made his will, and on May 2 of the same year he passed away.

Vasari informs us that Leonardo, “having become old, lay sick for many months, and finding himself near death and being sustained in the arms of his servants and friends, devoutly received the Holy Sacrament. He was then seized with a paroxysm, the forerunner of death, when King Francis I., who was accustomed frequently and affectionately to visit him, rose and supported his head to give him such assistance and to do him such favour as he could in the hope of alleviating his sufferings. The spirit of Leonardo, which was most divine, conscious that he could attain to no greater honour, departed in the arms of the monarch, being at that time in the seventy-fifth year of his age.” The not over-veracious chronicler, however, is here drawing largely upon his imagination. Leonardo was only sixty-seven years of age, and the King was in all probability on that date at St. Germain-en Laye!

Thus died “Mr. Lionard de Vincy, the noble Milanese, painter, engineer, and architect to the King, State Mechanician” and “former Professor of Painting to the Duke of Milan.”

“May God Almighty grant him His eternal peace,” wrote his friend and assistant Francesco Melzi. “Every one laments the loss of a man whose like Nature cannot produce a second time.”

HIS ART

Leonardo, whose birth antedates that of Michelangelo and Raphael by twenty three and thirty-one years respectively, was thus in the forefront of the Florentine Renaissance, his life coinciding almost exactly with the best period of Tuscan painting.

Leonardo was the first to investigate scientifically and to apply to art the laws of light and shade, though the preliminary investigations of Piero della Francesca deserve to be recorded.

He observed with strict accuracy the subtleties of chiaroscuro — light and shade apart from colour; but, as one critic has pointed out, his gift of chiaroscuro cost the colour-life of many a noble picture. Leonardo was “a tonist, not a colourist,” before whom the whole book of nature lay open.

It was not instability of character but versatility of mind which caused him to undertake many things that having commenced he afterwards abandoned, and the probability is that as soon as he saw exactly how he could solve any difficulty which presented itself, he put on one side the merely perfunctory execution of such a task.

In the Forster collection in the Victoria and Albert museum three of Leonardo's note-books with sketches are preserved, and it is stated that it was his practice to carry about with him, attached to his girdle, a little book for making sketches. They prove that he was left-handed and wrote from right to left.

HIS MIND

We can readily believe the statements of Benvenuto Cellini, the sixteenth-century Goldsmith, that Francis I. “did not believe that any other man had come into the world who had attained so great a knowledge as Leonardo, and that not only as sculptor, painter, and architect, for beyond that he was a profound philosopher.” It was Cellini also who contended that “Leonardo da Vinci, Michelangelo, and Raphael are the Book of the World.”

Leonardo anticipated many eminent scientists and inventors in the methods of investigation which they adopted to solve the many problems with which their names are coupled. Among these may be cited Copernicus’ theory of the earth’s movement, Lamarck’s classification of vertebrate and invertebrate animals, the laws of friction, the laws of combustion and respiration, the elevation of the continents, the laws of gravitation, the undulatory theory of light and heat, steam as a motive power in navigation, flying machines, the invention of the camera obscura, magnetic attraction, the use of the stone saw, the system of canalisation, breech loading cannon, the construction of fortifications, the circulation of the blood, the swimming belt, the wheelbarrow, the composition of explosives, the invention of paddle wheels, the smoke stack, the mincing machine! It is, therefore, easy to see why he called “Mechanics the Paradise of the Sciences.”

Leonardo was a SUPERMAN.

HIS MAXIMS

The eye is the window of the soul.

Tears come from the heart and not from the brain.

The natural desire of good men is knowledge.

A beautiful body perishes, but a work of art dies not.

Every difficulty can be overcome by effort.

Time abides long enough for those who make use of it.

Miserable men, how often do you enslave yourselves to gain money!

HIS SPELL

The influence of Leonardo was strongly felt in Milan, where he spent so many of the best years of his life and founded a School of painting. He was a close observer of the gradation and reflex of light, and was capable of giving to his discoveries a practical and aesthetic form. His strong personal character and the fascination of his genius enthralled his followers, who were satisfied to repeat his types, to perpetuate the “grey-hound eye,” and to make use of his little devices. Among this group of painters may be mentioned Boltraffio, who perhaps painted the “Presumed Portrait of Lucrezia Crivelli” (Plate VII.), which is officially attributed in the Louvre to the great master himself.

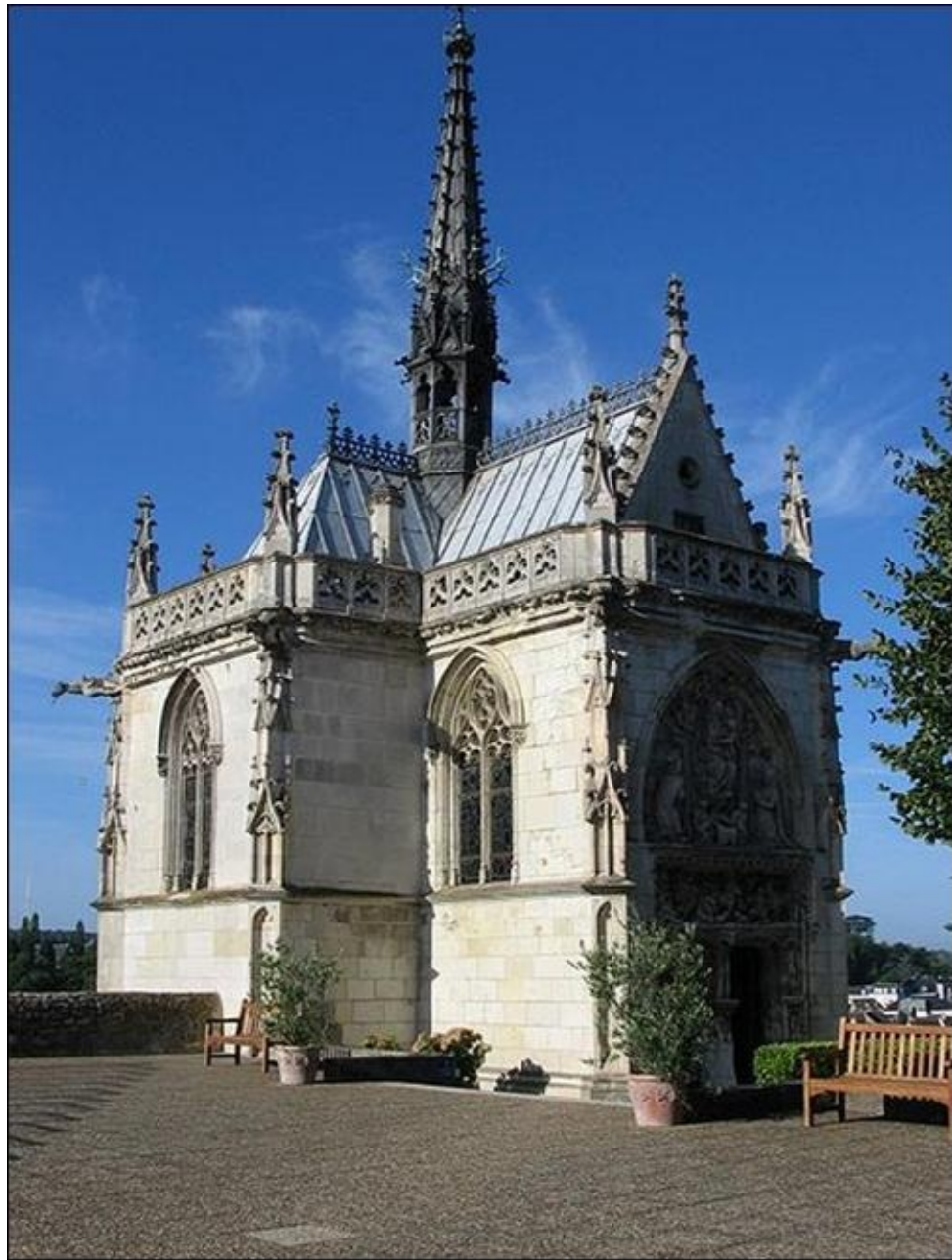
HIS DESCENDANTS

Signor Uzielli has shown that one Tommaso da Vinci, a descendant of Domenico (one of Leonardo's brothers), was a few years ago a peasant at Bottinacio near Montespertoli, and had then in his possession the family papers, which now form part of the archives of the Accademia dei Lincei at Rome. It was proved also that Tommaso had given his eldest son "the glorious name of Leonardo."





Amboise Forest, Centre Region, France — the alleged final resting place of Leonardo



Chapel of Saint-Hubert in Château d'Amboise



Leonardo's supposed tomb